ON DEDUCTIONS FROM METEOROLOGICAL OBSERVATIONS.

On Deductions from Meteorological Observations. By JOHN DREW, Esq., F.R.A.S., Member of the Council of the British Meteorological Society.

(*Concluded from page* 312.)

Mean Temperature.—Diurnal Range.

THE mean temperature of a month or year has heretofore been considered the arithmetical mean of the highest and lowest readings of the thermometer recorded during that period; thus it was thought, that if the maximum and minimum readings were added together, and divided by the number of observations taken during the time, the result would be the mean temperature for the period through which the register extended. Mr. Glashier has shown, however, that this estimate would be too high by a quantity varying with the month during which the observations were taken.

At the Royal Observatory, Greenwich, meteorological observations have been registered since 1840, every two hours, throughout the day and night. If the times of observation are taken as abscissæ, and the temperatures be projected as ordinates, that is to say, if a sheet of paper be divided into 24 parts, each representing an hour, and at each point perpendiculars be erected which shall be proportioned to the temperature of each hour, the line joining the upper extremities of these perpendiculars will represent the variation of the temperature during the day; the mean temperature will be represented by a straight line, which will cut off with the curve equal areas above and below.

In like manner, if the mean temperature of each month be projected, the mean temperature of the year will be represented by a line which shall satisfy the same conditions.

In the Philosophical Transactions, Part I. 1848, may be found a paper by Mr. Glashier, "On the Corrections to be applied to the Monthly Means of Meteorological Observations, taken at any Hour, to Convert them into Mean Monthly Values." In this he has shown, that to the mean of the observations taken during a month at any hour, a certain correction must be applied to deduce the mean value for the month. By a careful comparison of five years' observations, he has been enabled to tabulate these quantities, so that henceforth by applying them, the mean monthly value may be deduced from observations taken at any one hour during the day. Since the publication of these results, he has extended his comparison through a period of eighty years, during which observations on the temperature have been made at the apartments of the Royal Society, Somerset House, all of which he has taken the trouble to reduce; and he has found the same law of diurnal variation to hold good. The application of his corrections gives true results from the Oxford observations, and seem applicable to all places inland; but whether exactly the same quantities will suit every place in England, especially those on the coast, admits of a doubt; they certainly must be altered for Dublin, and for this reason, that the maxima and minima of meteorological phenomena do not occur at the same hour of the day, as at Greenwich; and the apex of the curve projected as above, denoting the highest temperature, is much more pointed; in other words, the greatest heat during the day is attained more suddenly, and declines more rapidly at Dublin than at the Royal Observatory at Greenwich. At the latter place, twice during the day, the mean temperature of the air is at its mean value, and these times are as follows in the several months:

		h. m.					h. m.	
In January	..	at 10 0	a.m.	..	and again	..	at 8 0	p.m.
In February	..	at 9 30	a.m.	..	and again	..	at 6 40	p.m.
In March	..	at 9 10	a.m.	..	and again	..	at 7 20	p.m.
In April	..	at 8 40	a.m.	..	and again	..	at 7 0	p.m.
In May	..	at 8 25	a.m.	..	and again	..	at 7 30	p.m.
In June	..	at 8 0	a.m.	..	and again	..	at 8 0	p.m.
In July	..	at 8 0	a.m.	..	and again	..	at 8 5	p.m.
In August	..	at 8 20	a.m.	..	and again	..	at 7 20	p.m.
In September	..	at 8 55	a.m.	..	and again	..	at 7 20	p.m.
In October	..	at 9 9	a.m.	..	and again	..	at 7 0	p.m.
In November	..	at 9 25	a.m.	..	and again	..	at 6 45	p.m.
In December	..	at 10 2	a.m.	..	and again	..	at 7 20	p.m.

At these periods the temperature changes very rapidly, or it might be advisable to take observations at the times above specified; but unless this were done with great precision as regards the local time, a small error in that particular would introduce a large one in the observations: it is, therefore, recommended, that the times of observation should be those least liable to interruption, and that they should correspond most nearly with those at which least changes are taking place in the elements, which times the tables will show.

If the mean of the daily registrations of the maximum and minimum thermometers be taken, the following quantities must be subtracted to obtain the mean temperature for the month:—

January	0·2°	April	1·4°	July	1·9°	October	1·0°
February	0·4	May	1·7	August	1·7	November	0·4
March	1·0	June	1·8	September	1·3	December	0·0

We have thus, then, two entirely independent methods of determining the mean temperature, which mutually check each other. One, from the mean of the highest and lowest readings of the thermometer minus the above quantities; the other, by applying Mr. Glaisher's corrections to the observations taken at any hour of the day. The first publication of the British Meteorological Society is a reprint of these tables, with the addition of another, showing that the amount of cloud is also subject to certain laws, and that the obscurity of the sky has its maxima and minima and mean amount as well as the temperature of the air. Not that these are the only variable elements in meteorological inquiry which obey definite laws; the mercury in the barometer fluctuates daily above and below the mean pressure, which may be ascertained by the application of the tabulated corrections. Four times daily the reading of the barometer is at its mean value: these times in the several months are as follows:—

		h. m.	h. m.	h. m.
In January	at midnight	at 8 0 a.m.	at 0 40 p.m.	and at 5 0 p.m.
In February	at midnight	at 8 0 a.m.	at 1 40 p.m.	and at 8 20 p.m.
In March	at midnight	at 7 35 a.m.	at 1 50 p.m.	and at 6 0 p.m.
In April	at 1 0 a.m.	at 6 40 a.m.	at 1 40 p.m.	and at 7 20 p.m.
In May	at 1 0 a.m.	at 8 20 a.m.	at 1 0 p.m.	and at 8 40 p.m.
In June	at midnight	at 4 20 a.m.	at 1 40 p.m.	and at 9 20 p.m.
In July	at 1 0 a.m.	at 6 25 a.m.	at 1 40 p.m.	and at 8 45 p.m.
In August	at 1 0 a.m.	at 7 0 a.m.	at 1 10 p.m.	and at 7 35 p.m.
In September	at 1 0 a.m.	at 7 50 a.m.	at 1 0 p.m.	and at 7 0 p.m.
In October	at 0 25 a.m.	at 7 50 a.m.	at 1 10 p.m.	and at 5 0 p.m.
In November	at 1 40 a.m.	at 8 20 a.m.	at 11 40 p.m.	and at 5 45 p.m.
In December	at 0 40 a.m.	at 7 40 a.m.	at 0 45 p.m.	and at 6 5 p.m.

By the application of the quantities in the tables, all of which have been deduced from observation, the following phenomena may also be reduced to their mean values:—

1. The mean depression of the temperature of evaporation below that of the air at the height of 4 feet above the soil at every hour in each month.

2. The mean depression of the temperature of the dew point below that of the air.

3. The corrections to be applied to the monthly mean elastic force of vapour, to deduce the true mean elastic force of vapour for the month from the observations taken at that hour.

4. For the mean quantity of aqueous vapour in a cubic foot of air.

5. For the mean degree of humidity.

6. To the weight of vapour in a cubic foot of air.

I trust that the explanations I have attempted will show that some progress has been made in the study of Meteorology, and will convince observers that their records may be of service in the cause of science, that they will excite an interest in inquiring minds, and direct their energies in a useful channel. It is incumbent on the engineer not to neglect the science which may assist him in supplying the increased demand for one of the necessaries of civilised life. The medical practitioner,—the recognised guardian of the public health—the mariner, on whom rests the responsibility of preserving life and property in crossing the ocean, and whose experience has taught him the necessity of marking atmospheric changes, cannot, with safety, disregard the science of Meteorology. The British Meteorological Society is intended to form a depôt for the valuable observations of the officers of the navy and mercantile marine; and that society will, I apprehend, soon enter upon some systematic arrangement for the purpose of gaining over such intelligent and competent allies. The agriculturalist is deeply interested in our progress, in order that his skill may be exercised in developing those natural productions which are best suited to the climate of the country he is called to cultivate. On this latter point I may appropriately quote the words of a late writer in the Royal Agricultural Society's journal, who has taken up the subject with great ability in an article 'On the Climate of the British Islands in its Effects on Cultivation.'

"Of what avail, then, it may be asked, is the knowledge of such a subject? That we may bend to the power we cannot control, and learn to adapt our culture to the capabilities of the climate: indeed, climate is the ruling principle of agriculture—the law which governs the productions of different countries; and he who yields the most enlightened obedience obtains the largest reward."

For the guidance of those who are interested in meteorology, I subjoin the results of my observations for the last quarter, in the form in which I usually print them for private distribution.

Results deduced from Meteorological Observations.

Taken at Mr. Drew's Observatory, Cumberland-place, Southampton,

At 9 a.m., 3 p.m., and 9 p.m. daily, during the months of April, May, and June, 1850.

Latitude 50 deg. 54 min. 34 sec. North; Longitude in time 0h. 5m. 37·7 sec., West. Height of Barometer above the mean level of the sea, 58 feet; of the Thermometers above the ground 4 feet 9 inches; aspect North.

	April.	May.	June.
Mean height of the Barometer corrected and reduced to the temperature of 32 deg.	29·756	[illegible]	30·062
Tension of aqueous vapour in inches	·316	·350	·427
Pressure of dry air	29·440	29·447	29·635
Deduced dew point	45·	48·9	53·9
Weight of vapour in a cubic foot of air (grains)	3·6	4·08	4·8
Required for saturation (grains)	0·82	0·74	1·73
Degree of humidity, complete saturation being 1	·814	·832	·740
Weight of a cubic foot of air (grains)	534·5	551·	547·
Greatest heat	64	73·3	82·
Least heat	36·2	35·3	39·8
Range of the Thermometer	28·8	40	42·2
Amount of rain in inches	4·781	2·268	3·099
Number of days on which rain fell	20	12	9
Highest reading of the barometer	30·257	30·239	30·374
Lowest " "	29·094	29·279	29·460
Mean temperature from the 9 a.m. observations	49·9	51·8	60·2
Ditto 3 p.m. ditto	47·9	51·6	59·7
Ditto 9 p.m. ditto	48·8	52·4	59·6
Mean of the three	48·8	51·9	59·8
Mean of the maxima	56·9	60·7	71·3
Mean of the minima	44	48·6	51·4
Mean temperature deduced from these	48·9	53·	59·6
Strength of the wind	·33	·29	·2
Amount of cloud	·7	6·6	4·4

For the explanation of the mode of deducing the mean temperature, see Mr. Glaisher's paper in the Philosophical Transactions, part I., 1848.

In estimating the amount of wind, a calm is represented as 0, a gale 6.

In estimating the portion of the sky occupied by clouds, a blue sky is represented by 0, a clouded sky by 10, at the time of observation.

In the deduced results, which will be found useful for comparing the climate of Southampton with those places from which reports are sent to the Registrar-General, the Barometer reading, when corrected, may be considered as showing the absolute height of the mercury at a mean temperature of 32 deg., after the application of various corrections, including one which reduces it to the Royal Society's standard, with which the instrument has been compared; but no reduction of the sea level has been applied.

For a full explanation of the various deductions, see Glaisher's Hygrometrical Tables, and the Report of the Royal Society on Meteorology.

THE GOVERNMENT AND PUBLIC ENTERPRISE.

We have often had occasion to point out the manner in which the public interests are sacrificed by the government, more particularly as affecting public enterprise; but we know few instances more flagrant than that of the claim of "foreshore." Is a sand to be embanked?—a harbour constructed?—or a river improved?—in steps the claim of some government board for whatever land may be recovered. This obstructive policy proves fatal on many occasions; and the most valuable enterprises are abandoned. If the government really represented the public, and discharged the duties incumbent upon it, it would be the most proper agency for taking charge of land reclaimed, for the very simple reason that the government would, agreeably to its duty, recover every portion of surface which could be made contributory towards the national subsistence. The government of Holland thus takes charge of the defensive works, and from time to time reclaims large tracts of land, as is now going on in the Haarlem Sea. The government of England does nothing of the kind; no public work of reclamation does it carry out; from all does it take toll if it can. Not content with mismanagement of the houses, woods, mines, and lands belonging to the public domain, it sets up a usurping claim, that all reclaimed land and the whole foreshore belongs to the crown; whereas, historical evidence abundantly proves that the crown could have no such rights, and that if any such existed, they belonged to the townships, the community at large, or such members as took possession of waste and reclaimed it. By land, the public rights are contested by the government; and by river and sea the same invasion extends. If Stephenson proposes a bridge over the Menai, or Brunel one over the Severn, the Admiralty steps in and prescribes conditions supposed to be impossible of fulfilment. Indeed, the conditions proposed to Robert Stephenson might have figured in the Thousand and One Nights, or the collection of the Comtesse D'Anois, as those proffered to some laborious gin or subtle fairy.

The reclamation of land is proposed in the Wash, Morecambe Bay, the Duddon, Loughs Swilly and Foyle, the River Dee, Langston Harbour, and many others. Yet, who knows of any countenance given by the government to undertakings which will add to the country one hundred thousand acres of the richest soil, and yield food for nearly half-a-million of people? The Norfolk Estuary plan, now at length about to be begun, requires only a relatively small capital; but so far from the government contributing towards the funds, it has been the obstacle in the way of their being raised. The corporation of Lynn contributes 60,000*l*., the landowners of the neighbourhood a large sum—but what does the government contribute? Here, six and thirty thousand acres will be brought under cultivation, and the cultivation and navigation of millions of acres in the upland will be improved. This is a case, one would think, urgent on the government of a rich country, and which levies such a large amount of taxes for unproductive purposes.

Look at Birkenhead. There the government actually attempted to mulct the parties of 100,000*l*., although it had refused to contribute a halfpenny towards the reclamation of the foreshore to which it propounded a title.

In the instance of Morecambe Bay—which, though not the original project of George Stephenson, remained his favourite undertaking to the last day—when it was proposed to reclaim above thirty thousand acres, and when even the freeholders and lords of the manner had given way; when the Duke of Buccleuch and the Earl of Burlington had given their sanction, the two government departments of the Woods and Forests and the Duchy of Lancaster, each set up a conflicting claim to the whole, and the Admiralty interposed to set up hindrances. All the noble lords, and others promoting the undertaking, could get from the government was, that they might reclaim the land if they got the consent in parliament of the Woods and Forests, the Duchy of Lancaster, and the Admiralty; and the government would then see what it would take as its share. This was so futile that the promoters of the plan were at that time forced to abandon it.

The result was this, that whereas an embankment carried right across the bay would have borne a short line of railway, and taken in a great area of soil, the railway actually made has been successively altered in its plans, so as to hug the land, and sacrifice the original objects of the project.

Lough Swilly and Lough Foyle present no more encouraging results. A considerable sum has been expended; but though a small amount of government aid would ensure success, the undertakings remain in abeyance. Solvent contractors are willing, on low terms, to execute the necessary works for embanking the slob; but in the depression of all public undertakings the company cannot obtain capital, and the government will not lend it.

At present the government is engaged in a long Chancery suit, to wrest from the Corporation of London its long-possessed jurisdiction over the banks and bed of the river Thames; though no one thinks the government would manage the river better than the corporation. Indeed, had the latter the proper powers, it might effect the embankment of the river throughout its course, and remedy evils which are attributable solely to the obstructiveness of the government, which does not leave freedom of action to the corporation.

Half-educated politicians may doubt the value of railways, canals, docks, harbours, and other works, which they consider only promote distribution; but they are forced to allow that every acre added to the surface of these islands is an addition to our means of production. To increase these means of production is one of the first duties of a community and a government; and no practical man who has ever examined the question fails to recognise that abundant opportunities exist for the proper application of the labour and resources of the nation on many parts of our coasts. So long, however, as the fictions of lawyers, and the unfounded claims of government departments are allowed to stand in the way, these resources must remain in abeyance, and the progress of improvement limit itself to the single or few fields reclaimed by the landowner, who is not forced to come into contact with the government or the legislature. The present state of matters constitutes a grievance which prevents the application of hydraulic engineering and the development of the national resources.

ORDNANCE SURVEY OF SCOTLAND.

Our attention has been called to the present state of the Ordnance Survey of Scotland, by a very able article in our Edinburgh contemporary, the *Scotsman*, and it induces us to claim the public consideration on a matter of very considerable professional interest. In London we have been interfered with by the military surveyors, and, it is now known, to the public prejudice. Those who objected to it at that time were considered factious, and perhaps we may be so called for referring to it now, but there are too many commissioners and jobbers at large not to make us wary; and we think it necessary to warn the public, from the experience of the past and the example of the present, against trusting anything more than they can help to the direction of the government and its boards. Edinburgh and Scotland are not better off than London—the Ordnance Surveyors are behind time; and if the present course is to be followed up, there is no telling when the Survey may be completed. The British Association in its meetings in Scotland has had some influence in urging the Ordnance to the work. Every meeting is marked by impatience at the non-completion of the Survey. In 1834, sixteen years ago, when the Association formerly met in Edinburgh, they urged this question on the attention of the government; and we must own it marks a degree of apathy to the wants and interests of the country, that in 1850 a meeting should have again to move on the same question. In the "Synopsis of Recommendations" handed to members on the last day of the Association, was the following notice:—

"That a committee, consisting of the President, the Duke of Argyll, Sir R. I. Murchison, Professor J. Forbes, and Lord Breadalbane, be appointed for the purpose of urging on her Majesty's government the completion of the Geographical Survey of Scotland, as recommended by the British Association at their former meeting in Edinburgh in 1834."

Those who know what government boards are, will not expect too much from this strong hint; and the *Scotsman* particularly remarks this, and urges the necessity of public bodies and private individuals following up the demand. It says:

"Notwithstanding the well-known energy and influence of the members of the above committee, the last line of the resolution does not permit us to hope that it will effect much good, unless followed up by similar and more continuous efforts on the part of other individuals and public bodies. Had the sixteen years that have elapsed since the former recommendation been rightly employed, this resolution would not have needed to appear in the proceedings of the Association."

No one will be surprised to learn that in sixteen years nothing has been done. A great part of the map might have been completed, and the remainder so far advanced as to give us some hopes of living to see its termination. Instead of this, only a few sheets of one county have been finished; and at the present rate of progress, it is computed half a century will be required before a complete map of Scotland is produced. The Ordnance Survey of Scotland and the British Museum Catalogue may perhaps be finished at the same time; and if not out of date in their earlier portions, be of use to our great-grandchildren.

We are informed, that all the great system of triangulation is completed, and that the work which now remains to be done is merely the filling-in of the subordinate details. Every body knows men capable of performing this work can be procured in any number, and for very moderate pay—as the Ordnance Surveyors of the metropolis, the corporals and privates, can give evidence.

The way in which this system of management works is most sickening: it not only does not the good it professes to do, but hinders others from doing good. Our contemporary gives flagrant proof of this. He says, the Government Survey is the great barrier to any attempt at the improvement even of the local maps. No publisher dare venture on the expense of a new survey, or even on a thorough collation of the existing materials for correcting the map, with the fear of a government map before his eyes. We agree with him, that private enterprise would long ago have produced a more perfect map, and that the speculation would have been successful, had not the public survey stood in the way—like the dog in the manger, neither eating itself nor allowing others to do so. Were it fully understood the Scotch are to have no government map for the next twenty years, even yet private enterprise would undertake it; but no publisher is safe in surveying even a single county or correcting a single sheet of a map. In example of this is quoted the case of the survey of Edinburgh, by the Messrs. Johnston—which was no sooner completed on the government scale, and the first sheet published, than the official surveyors were brought down from the extreme south of the kingdom, and the whole work begun anew at the public expense.

THE SHIPBUILDING TRADE OF LIVERPOOL.

Liverpool is forced to be great, not only by her own progress, but by the rivalry of Birkenhead; and the public can never be surprised to hear of any gigantic enterprise in which she has engaged. Her docks and warehouses are among the wonders of England; but she contemplates new works, on which the *Liverpool Times* speaks at length:—"No one can read," says our contemporary, "the evidence taken before the Committee on Shipbuilding without perceiving, that in obtaining the indispensable object of a sufficient supply of dock accommodation, we have sacrificed the highly-desirable object of a sufficient supply of accommodation for shipbuilding. The only manner in which these two objects could have been combined without forming a great number of new docks, and setting aside new land for the shipbuilders, would have been by adding to the real amount of dock accommodation, by building warehouses round the already existing docks, and by introducing other means of economising dock space, connected with that grand improvement, and altogether impracticable without it. Had this been done when it was proposed by Mr. Eyre Evans, not only might Calcutta ships have been discharged in three or four days, instead of three or four weeks (as Mr. J. A. Tobin says they now are), but all other ships might have been discharged at the same rapid rate. Thus, very few new docks would have been necessary; and Mr. Wilson, and the other shipbuilders, might have retained their building yards, for another generation at least. Unfortunately for the town, that proposal was defeated by personal interests, combined with party spirit; and having been defeated, there remained no other means of providing for the rapidly increasing commerce of the port, than by forming a great number of new docks. This could not be done without expelling the previous occupants of the land on which they had to be formed. Thus the refusal to build warehouses round the docks rendered the forming of new docks necessary; and the taking of ground for them has pretty nearly annihilated the shipbuilding and engineering of the port, and has diminished to an enormous extent the amount expended in the town in wages."

This affords a very clear view of the difficulty in which Liverpool is now placed; but it seems by a remarkable instance of retributive justice, the opponents of dock warehouses have been amongst the principal sufferers from the course of proceedings which they rendered necessary. The closing of the ship-yards, and the diminution of the amount of employment in the foundries, have had the effect of emptying thousands of houses, and of adding frightfully to the pressure of poor-rates, both on warehouses and houses.

The tonnage of the port has nevertheless increased from 1,223,318 tons in 1836, to 3,309,746, in 1849. There were only two ways of meeting this increase; the one to make the existing docks do double or treble duty by improved modes of working; the other, to form a multitude of new docks. The former course being rejected, nothing remained but to adopt the latter.

It is well observed, that what renders Birkenhead formidable to Liverpool, is the admirable arrangements made for landing goods, and forwarding them into the interior. There the warehouses are so built that goods can be craned up from the holds of the vessels which import them, on one side, and lowered into river boats, or railway trucks, on the other. At Birkenhead there will be no cost of cartage on goods sent at once into the interior; no danger of pilferage; no unnecessary loss of interest on ship or cargo, and no loss of a favourable market or of a handsome freight.

With regard to the plan proposed by the Shipbuilding Committee, and explained in the Town Council by Mr. J. Aspinall Tobin, we understand it to be, that the present building yards should be made as convenient as possible, and that fourteen new building yards, each containing about 10,000 square yards of land, should be formed north of the Sandon Dock. These are to be furnished with private graving-docks, at the cost of the Corporation, the tenants paying five per cent. interest on the cost of the graving-docks, and 8*d.* a-yard rent for the land; and being secured in the possession of the land by leases long enough to induce them to erect first-rate machinery for shipbuilding, and the necessary buildings.

GERMAN ARCHITECTURE.

The capital, fig. 1, belongs to a column supporting the roof of the Great Hall, called Land Grafenhaus, Wartburg, Germany. It is of the 17th century, and should be deemed perfect in originality of design; without being much undercut, it is deeply wrought. We trust this beautiful specimen may in some way prove suggestive.

The capital, fig. 2, is from the remains of the choir in the Church of St. Peter and Marcellin, Seeligenstadt, Germany, and may be considered remarkable for its elegant and beautiful proportions in any age ,but the more so when we are told it dates as far back as the 13th century.

CHARLES THE SECOND'S BATH, BATH STREET, NEWGATE STREET.

SIR CHRISTOPHER WREN, Architect.

(*With Engravings.*)

To be whirled along the surface and through the bowels of the earth, with fearful velocity, by the strength of a creature of men's formation, docile as a horse, feeding on flames and boiling water, is not the only novel feature of society at the present day; the desire on the part of the masses to move fast and indulge a commercial spirit on a gigantic scale, is accompanied by a love of cleanliness and a disposition to extend the means of relaxation and healthy enjoyment; thus, Baths, with those useful concomitants Wash-houses, are fast springing up for the use and wholesome recreation of the hard-worked million. The term novel, can indeed, be rigorously applied only to one of the above-named features, since the erection of Baths on so large a scale as to warrant the appellation of "national," is nothing more than the revival of a very ancient custom. That the "rail" is in its infancy is a true and trite remark; what may be its true character when it has reached maturity, none can predict; time alone can unfold the mystery: but with respect to "Baths," we know what has been done by the ancients. On the score both of utility and splendour, the baths of the Romans left nothing to be desired; it were in vain to hope to eclipse them. "In those buildings, Architecture developed all her resources, and robed herself in a profuse display of the most costly materials; therein it distributed in an orderly manner, the choicest productions of art, and by the application of columns, and other architectural details, all ingeniously contrasted, it produced in one immense design the most striking and varied effects. It offered, in the interior especially, decoration of the most fascinating as well as of the most imposing character, whilst it displayed externally all the sumptuosity of amphitheatres, vast terraces, porticoes, and delightful gardens."

We see, then, that with respect to such buildings, we are yet some way behind; but we also see plainly what we have to achieve; and, with the energies of Englishmen is it too much to imagine, that we may ere long rival Rome in our Baths?

It has become the fashion to anticipate time: 1850 seems fairly to be forgotten in the vehement desire which all are seized with to behold the giant offspring of 1851. In obedience than to the fashion of the times, let us contrast the National Baths of 1850 with what similar establishments may possibly be in 1860. Piercing then through the veil of time, we see the Bath having become the popular feature of the day: Baths—not merely troughs in which to wash the body, but establishments in which the intellectual as well as the physical wants of man are ministered to. Complicated buildings, wisely planned, covering immense areas, in which are united all things necessary to the complete unbending of the body and mind; in which, moreover, the fullest scope is given to the display of the arts—of the leading arts of painting and sculpture especially; structures in which much is combined for the mental training as well as for the bodily recreation of masses of beings deprived of other means of acquiring polite instruction, through the necessity imposed upon them of daily toil. This too faint a glimpse at the development of so important a feature as that of the Bath, supposes the exercise of much taste and judgment, if not of genius, in the supervision of such a scheme. If it be true that many circumstances combine to render it not improbable that the construction of Baths will become a favourite subject with the English, then is it well that we should familiarise ourselves by times with good models on which to shape our future plans; and it is gratifying to know, that however advisable it is to consult foreign examples for such a purpose, we have matter of the kind at our own doors worthy of the greatest attention.

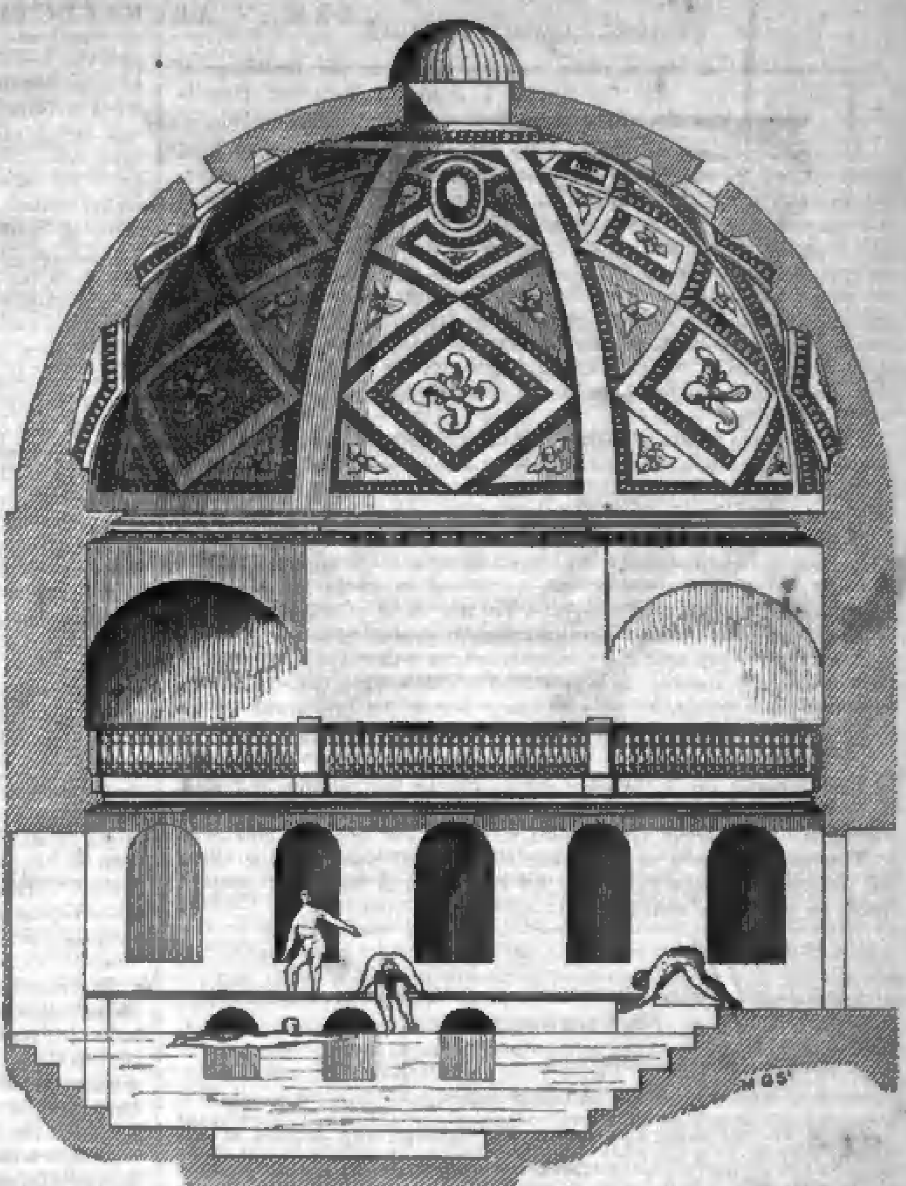
To no greater teacher of architecture can we go than to Sir Christopher Wren; and to a Bath designed by that great architect is the attention of the reader now solicited. The Bath in question was erected for the use of King Charles the Second, and stands at the end of Bath-street, Newgate-street, in the neighbourhood of St. Martin's-le-Grand.

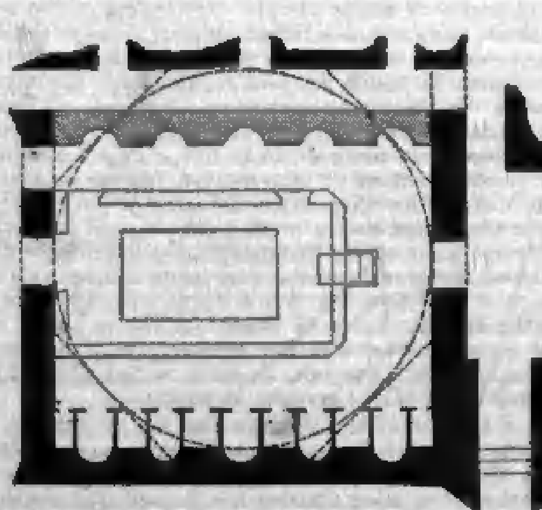
The boundary walls of the bath form a square: the dressing closets and the seats are made to project on the right and on the left into the chamber, and are surmounted by a balustrade, which is carried round the whole of the interior. At the back of the seats is a passage communicating with private baths; the dressing closets abut against the boundary wall. Above the balustrade the

chamber is worked into an octagon by means of arches at the angles of the boundary walls, and the whole is crowned by a hemispherical dome. The floor of the bath is paved with marble slabs, and the sides, up to the balustrade, are lined with Dutch tiles. The dome is of brick, ornamented with coffers executed in plaster.

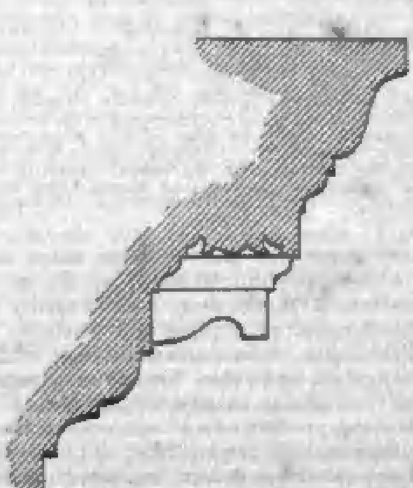
To the uninitiated alone is it necessary to remark, that Sir C. Wren has invested his buildiing with an appropriate character; the interior, which is beautiful, is stamped with an air of tranquility and cheerfulness highly characteristic of the use to which it is designed. Not only is the general scheme admirably conceived, but every detail, both for usefulness and beauty, minutely attended to; thus, the niches in the room itself are ornamental seats; those in the sides of the plunging bath are principally for the purpose of breaking the action of the water, and preventing the latter from spreading into the room when agitated by the bathers; rings, for the purpose of holding-on in the water, are so placed as to become real ornaments. A well-modelled lion's head conceals the spout which admits the flowing stream; another similar head masks the opening to a drain which conveys away all grease and oiliness which are apt to collect on the surface of a bath. There was originally no aperture in the wall of the chamber to admit light; hence a sense of security as well as of seclusion was created, by which the pleasure of the bath is greatly enhanced; the dome—gracefully panelled—alone admitted the light. The cornice to the chamber bears the impress of thought and study, the individual mouldings being so modified as to render them applicable to an interior *only*. In short, to whatever point our attention is directed in this unpretending and charming building, studious care and propriety of motive are conspicuous, and, like all the works of Sir Christopher Wren, this building of 200 years' standing is still a model to future times.

To many this bath is well known, it being in full operation: to too many it is unknown. The publication of the building may therefore be considered in some respects as a disinterment of a monument of taste and utility. The City of London abounds with hidden ornaments of this kind. As the ivy is wont to grow round noble trees, veiling the beauty of the latter, so many noble structures of by-gone times are concealed by the brick





Plan of Bath.



Profile of Cornice.

and mortar incrustations of this latter age; and as it is the duty of a vigilant gardener to free the stems from parasytical plants, so is it the duty of the architect to pierce through those excrescences which, through time and necessity, have encumbered the choice fruits of architectural genius.

A. W. Hakewill.

London, October 10th, 1850.

CHAPEL ARCHITECTURE.

Chapel and School Architecture, as appropriate to the Buildings of Nonconformists. By the Rev. J. F. Jobson. London: Hamilton, Adams, and Co. 1850.

The clerical title attached to the name of the writer may lead some of our readers to take him for an amateur; but it seems Mr. Jobson was articled, at Lincoln, to Mr. Edward James Willson, F.S.A., and left the drawing-board for the Wesleyan ministry; nor has he since been totally disconnected from architectural pursuits, having been for many years secretary of the Wesleyan Chapel Building Committee. In this capacity he has rendered some service to architecture, having greatly influenced the movement for building chapels in the Gothic styles, and of more architectural character, and having published several articles on the subject in the *Watchman* newspaper, which now form the beginning of the work before us.

These observations will cause our readers to feel a greater interest in the work, and will enable them to judge of its especial tendency, which is to promote improved architecture, and the employment of the mediæval styles, at the same time giving such counsel to the ministers and other officials interested as may enable them to co-operate with the architect, and obtain an efficient building. We may hereafter have occasion to notice Mr. Jobson's remarks, advocating and enforcing the necessity of strictly acting under professional advice in all structural operations.

Mr. Jobson very naturally introduces his subject by an appeal to the higher emotions, of which religious architecture is the exponent, and sympathy with which is too often lost sight of by many well-intentioned but little reflecting persons.

"What surpassing power there is in the mere theme of religion to impel human energy to its highest efforts, and to enable genius to transcend the artistic description of merely mortal concerns, let the immortal poem just quoted testify. The greatest triumphs in music—the 'Messiah,' with its unequalled grandeur and pathos; the 'Israel in Egypt,' with its overwhelming choral magnificence; the 'Creation,' with its elevated joy and rapt sweetness; the 'Mount of Olives,' with its wondrous sublimity,—all bear witness to the might there is in the theme of religion to raise and sustain the powers of genius in its noblest exercises. The most perfect achievements of the pencil—those of Raffaelle, and Michael Angelo, and Leonardo da Vinci—verify the same position. Sculpture is an art which, in modern times, has been merely imitative of ancient models; and those models of perfectness were, notoriously, connected with religion. Ancient poets, like ancient sculptors, consecrated their best efforts to religion; and seemed, indeed, as if they dared not to begin to sing without invoking the aid of Divinity, under such imperfect conceptions as they had of the Divine Nature and existence.

"The writer of these remarks is, nevertheless, not pleading for a high style of elaboration and ornament in the erection of Wesleyan Chapels. He is prepared to maintain that they should have no *unnecessary* adornment. Let open spaces for hearing the word of God, and for prayer be inclosed with walls and roofs. But, however plainly constructed, our chapels should be of suitable forms and in good proportions; these will not increase their cost. Simplicity, rather than profuse elaboration, is the characteristic of beauty. Deformity shocks the universal taste of civilised man. How symmetrical, how simple and pleasing in their forms, are all the works of God!"

Our writer next discusses the question of style, and his predilections, as much as anything else, lead him to the preference of the mediæval styles, for which he is an enthusiastic votary.

"A Methodist Chapel is a place for Christian worship. If then, any style of architecture can be shown to have arisen out of the Christian religion, and to have been moulded by, and associated with it, from early times, so as to have become the outward and visible representation of Christian worship,—it is reasonable to say that such a style should be preferably selected; more especially if it can be shown that this *Christian* style of architecture is not inferior to any other style ever devised; that it is not more expensive; and that it is better adapted to the country and climate in which we live. Such a style is that usually called 'Gothic.'

"Gothic architecture is Christian architecture, as distinctly and emphatically as the Egyptian, Greek, and Roman, are Pagan.

"Grecian architecture was, in its origin, wooden. It was first composed of trunks of trees, with lintels laid across the top, and with rafters resting upon them. These were afterwards covered with ornaments; and when the Greeks came to employ marble and stone for building, they retained the same wooden type, and even moulded and carved their ornaments to represent the beam ends, and the wooden finish they originally made. Besides, a Grecian temple was made for offering animal sacrifices. The priests, only, went within, while the worshippers remained *outside*. The interior was comparatively small and dark, being only lighted from the top; and if, in professed imitation of the true classic model, windows be made in the front and at the sides, and the interior be large, seated, and galleried,—the proportions and beauty of a pure Grecian building must be violated.

"Again, the roof of a Grecian building is low. A high pitch was not required in the climate of Greece. With us, roofs must be constructed so as to resist the weather, and most readily throw off snow and rain; so that a much higher pitch of roof is required."

The next point Mr. Jobson proceeds to urge on the Wesleyan body is a very important one—the question of expense; and his remarks will not fail to command the attention of architects, because this is one of the points on which they are often called upon to do battle in the cause of their art. Mr. Jobson contends, and all practical men will go with him, that good architecture is, at any rate, not more costly than bad, and that, indeed, the balance is against the latter. He shows, moreover, that whatever false economy may plead, the paid services of a good architect are better than the unpaid and voluntary services of no architect, or of an amateur, however well meaning. His remarks are—

"In adopting Gothic Architecture, we need not be inconsistent with our professed form of Christianity, as Protestants, and Methodists.

"But it may be said that Gothic Architecture, while appropriate in the erection of churches, is not so as to chapels; and being, as it is generally supposed, much more expensive than the Grecian or Roman style—that is, if carried out in all its details—it would be imprudent for Methodists, who have no 'government grants' for chapel-building; who are not partakers of 'Queen Anne's bounty;' and who have no landed property to support their fabrics with the necessary repairs, to adopt such an unsuitable and costly style. The answers to such objections are brief and decisive. The Gothic style of architecture is as fully suited to chapels as to churches, and much more so than either Grecian or Roman. These 'classic' styles, as already shown, must be barbarously interfered with, in their proportions, to place tier above tier; to make numerous openings, both in the front and sides, for windows; and to cover the whole with a roof of such a pitch as to be suitable to our climate. On the other hand, Gothic architecture admits of expansion or contraction to any extent. It may be as lofty in its erections, or as low as we please. It may be simple and economical in its forms, as in the Early English—moderately ornamental, as in the Decorated—or elaborately adorned, as in the Perpendicular. It has models, from the plainest chantries, which are small in their dimensions, to the spacious and sumptuous chapels of St. George's, Windsor—Henry VIIth's Chapel, Westminster—or that of King's College, Cambridge.

"And, as to *Expense*, it is a mistake, fostered by prejudice, to suppose that Gothic Architecture is necessarily more costly than Grecian or Roman. In the forms most frequently employed in the erection of ecclesiastical buildings, it is the cheapest. The District Church Building Committees, and the Free Church of Scotland, have proved this for themselves. And the Methodists have *proved* it. The Model Plan Committee, appointed by the last Bristol Conference, applied to six of the most able architects, residing in different parts of the kingdom, for designs, specifications, and estimates, in their quantities and prices, of a chapel to accommodate seven hundred and fifty persons, in Gothic, Grecian, or Roman styles; each architect to supply two designs—one in Gothic, and the other in Grecian or Roman—with their estimates. The result was, that in *every* case, the estimated cost of the erection of the Gothic design was *less* than the estimated cost of the others; and, in some instances, considerably less. And this is what might be expected; for one great recommendation of Gothic Architecture is, that it employs no unnecessary forms *merely* in the way of ornament, as other styles do. It requires no expenditure of 500*l.* on five or six heavy and lofty columns to support nothing, as does Pagan Architecture. I know of one Grecian front of a Methodist Chapel which must, with its quadrangular tiers of columns and entablature, and with its flight of numerous steps (necessary for its elevation, but most dangerous in frosty weather—and, at all times, difficult for the aged), have cost as much as all the chapel besides. And I could name another Grecian Chapel in Methodism that had no less than 500*l.* expended on its fluted-columned recess for the Communion-Table,

almost wholly hidden behind the Pulpit and the Reading-Desk; and which Chapel left the Trustees with a debt, that by its many thousands, has oppressed them most grievously. But I forbear, for while I write *freely*, I must not even seem to condemn good and generous men, who, in their great zeal for God, committed, unintentionally, some improprieties.

"Gothic Architecture requires no such extravagant outlay for ornament. All its ornaments are parts *necessary* for the strength and convenience of the building. Its buttresses support and strengthen the walls, and make them as strong as if twice as thick. Its mullioned windows prevent the blinding glare of a mass of light, such as shines in a large Grecian opening. Its pillars, if within, support the middle roof, and hold fast the gallery. Its pinnacles, by their pointed forms, throw off the wet from the buttresses, and prevent injury; and its parapets, cornices, and basement-mouldings, are all, if properly employed, conductors of water from the building. It requires no artificial accompaniments —such as do-nothing front gables with blank windows and with iron bar supports behind. It is—incontrovertibly—the most *consistent* and the most *economical* style of Chapel Building that can be employed."

It will be seen Mr. Jobson does not rely upon theory or upon arguments *à priori*, but he appeals to the experience of facts; and besides those already adduced, he gives abundant evidence in the course of his work that he does not speak without authority.

Lately, in noticing a chapel, we had occasion to point out that the requirements of the congregation were not always so well attended to as in the design to which we were referring; and we are glad to have the opportunity of referring those architects who wish information on the subject, to the pages of Mr. Jobson's book. This writer remarks, that the nature of the accommodation required was a subject which particularly attracted the attention of the Building Committee appointed by the Wesleyan Conference in 1846. He says:—

"It appeared to the committee that, in preparing to erect Wesleyan chapels, sufficient consideration had not generally been given to the want of *Class-rooms* and *Vestries*. These are indispensable to the working of Methodism in the present day. Formerly, they were less needed than they are now. In the past time, classes were scattered, as to their places of weekly meeting, throughout a city or town; but, of late years, there has been a growing feeling towards meeting for weekly fellowship on the chapel premises. Class-rooms on chapel premises must, in the present day, to a much greater extent than formerly, be provided. In addition to these, it is also requisite that, in connection with a chapel of considerable dimensions, at least one larger room for *prayer-meetings* and *social gatherings* should be supplied. The increased agencies of Methodism require this. Of course, additional buildings will require additional expense; and it is important that ministers and trustees, in their first meetings for the erection of a new chapel should consider that, as Methodists, they have not only to build a chapel, but also vestries, class-rooms, and a larger room for prayer-meetings, annual or other tea-meetings, &c.

"Another consideration which engaged the attention of the committee, was *the arrangement of the buildings in such a manner as most easily to admit of enlargement when required*. And the committee found, by applications to practical men, that it would be easy, generally, to provide for enlargement, by including the class-rooms, and the larger room over or below them, under the roof at the farther end of the chapel. On this plan, the roof not having to be disturbed, it would be necessary only to take down the wall behind the pulpit, and the floor and cross-walls of the rooms behind; and then the chapel would be enlarged."

This latter consideration is one very important and applicable to churches, as well as to many classes of public buildings; where, in consequence of its neglect, very serious and needless expense is in a few years created, or very great inconvenience submitted to, and which judicious arrangement in the first instance would have avoided; nor are many of our leading architects free from forgetfulness in this respect.

"Another and a very important object to be seen in Methodist chapels, and which was carefully and anxiously considered by the committee, was *the furnishing of seat-room for the children of Sabbath and Week-day Schools*.

"A farther important subject, which engaged the serious deliberations of the committee, was *seat-accommodation for the Adult Poor*.

"There is another subject which demands the serious consideration of Ministers and Trustees who may engage in chapel building; and that is, *the evil*, as I regard it, *of erecting very large Methodist Chapels*. It may be found expedient to have one large chapel in the central part of a populous city or town,—to be used on general occasions, such as the District Missionary Anniversary; but, to erect several such chapels in one town, is likely to retard the progress of Methodism, rather than to promote it. If two moderately-sized chapels were built instead of one of great dimensions, each containing, say, a thousand, or twelve hundred persons, of course, two Ministers would be required for their supply, instead of one, as in the case of the very large chapel. And who, that considers all the circumstances to be taken into account on this subject, will not say, that a thousand or twelve hundred persons are quite as many as should usually be assembled together for worship in one building?

"And if chapels of moderate dimensions be built, it will be found that the present plan of raising very *deep and heavy galleries* within them is neither necessary nor expedient. The introduction of galleries into buildings for divine worship is comparatively recent; and was resorted to rather in the way of a temporary convenience, than as a principle to be continued and permanently carried out. Perhaps congregations rapidly increased, as did the congregation at Kidderminster, under zealous Richard Baxter, who had not less than five galleries in his church, and some of them most grotesque in their forms. To place the greater portion of the congregation in the gallery, is like putting the pyramid to stand on its apex, rather than on its base; and is as contrary to the right order of things, as seating some five hundred persons in a gallery *behind* the minister. It is better, where circumstances will allow it, to have no side galleries. There may be an end gallery, without much interference with convenience or order; and, if the congregation should much increase, and that quickly, side galleries might *then* be added, and thus enlarged accommodation be readily made, and at a comparatively small expense. But it is better for the Minister, who, if not surrounded by galleries, can nearly see all his congregation at one view;—it is better for the worshippers, who shall have their faces all turned one way, and that towards the minister, rather than be looking at each other from opposite sides of the chapel;—it is better for the whole congregation (for it is next to impossible to ventilate thoroughly a chapel choked up with huge galleries) to have but a moderate number of sittings in the upper part of the building. And, where sufficient ground can be obtained at a reasonable price, it will not be found much more expensive to build a chapel with a larger area, and which, having no ponderous galleries to support all round its interior, may be comparatively low in its walls, and light in its materials. Indeed, the best practical men that I have conversed with on this subject have declared that, under ordinary circumstances, they would undertake to erect a chapel to accommodate a thousand or twelve hundred persons *on the ground-floor*, for as little expense as they could build one that would accommodate the same number, having galleries on three or four of its sides. I am not urging the entire exclusion of galleries, but the *moderate* use of them; and would say, let the gallery that may be put up look as if it were built for the chapel, and not the chapel appear as if it were built for the gallery.

"*There should be no aisle down the middle of the chapel*, but seats: it being much better for the preacher to look directly upon his hearers, than upon an open space.

"*There should be no gallery behind the pulpit*; lest the Minister should be annoyed by the shuffling of tune-books; or the worshippers should be disturbed in their devotions by the movements in the orchestra."

The question of galleries is one which frequently comes under the consideration of architects; and, therefore, we have been induced to extract from the work on this subject at greater length than we otherwise should have done, because it gives the opinion of a man who may be considered, in a double capacity, as a practical authority.

MR. PATRIC PARK is fond of bold undertakings, and the one we now notice is bold and novel. It seems a gigantic model of his proposed statue to Wallace is to be erected at Glasgow, on the area near Burns's Monument, for exhibition. The proceeds are to form the nucleus of a fund for the erection of a national monument to the hero, to be placed in an important situation in the city, hereafter to be decided on. The intended monument will stand fifteen feet high without its pedestal, and the model has consumed nearly twelve tons of clay, every pound of which the artist himself carried to the spot upon his own shoulders. We think this a very good and legitimate proceeding, and we trust Mr. Park will be successful in his endeavours.

SPECIMENS OF ORNAMENTAL IRONWORK.

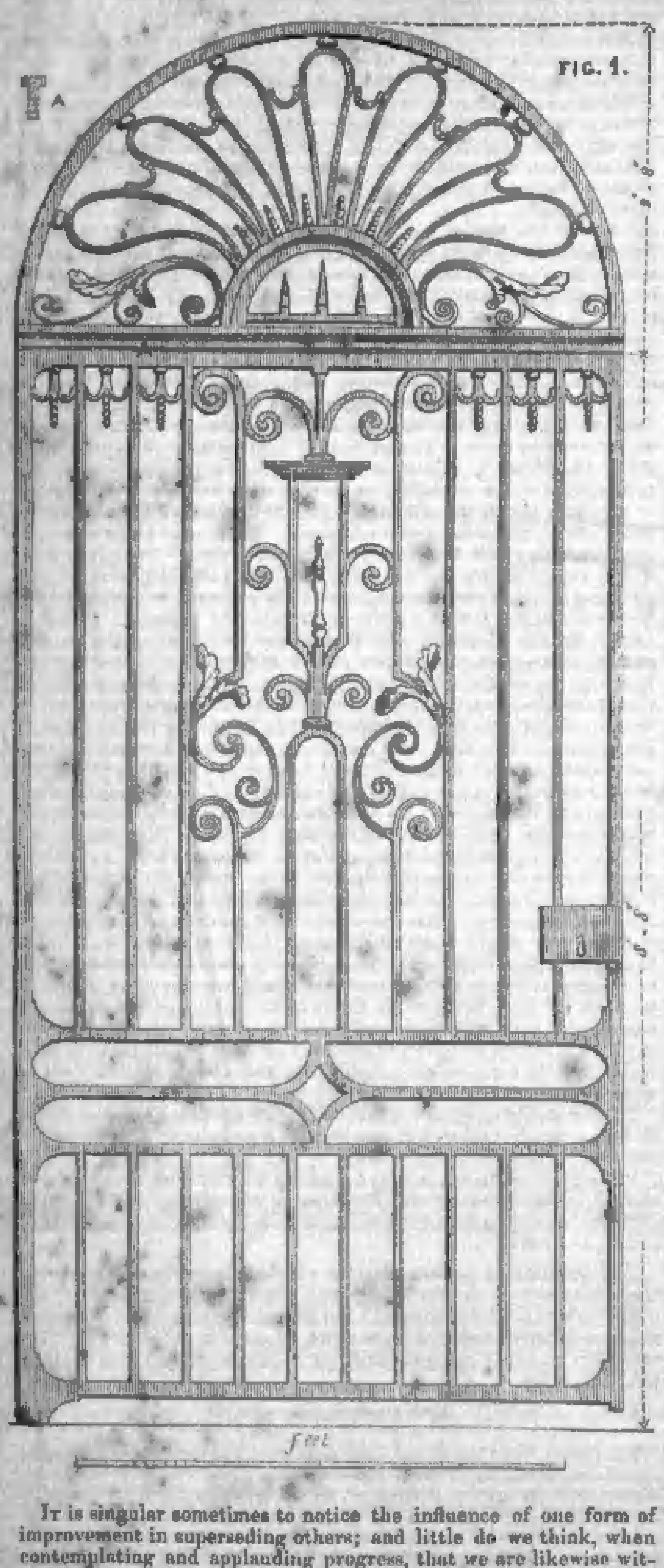


FIG. 1.

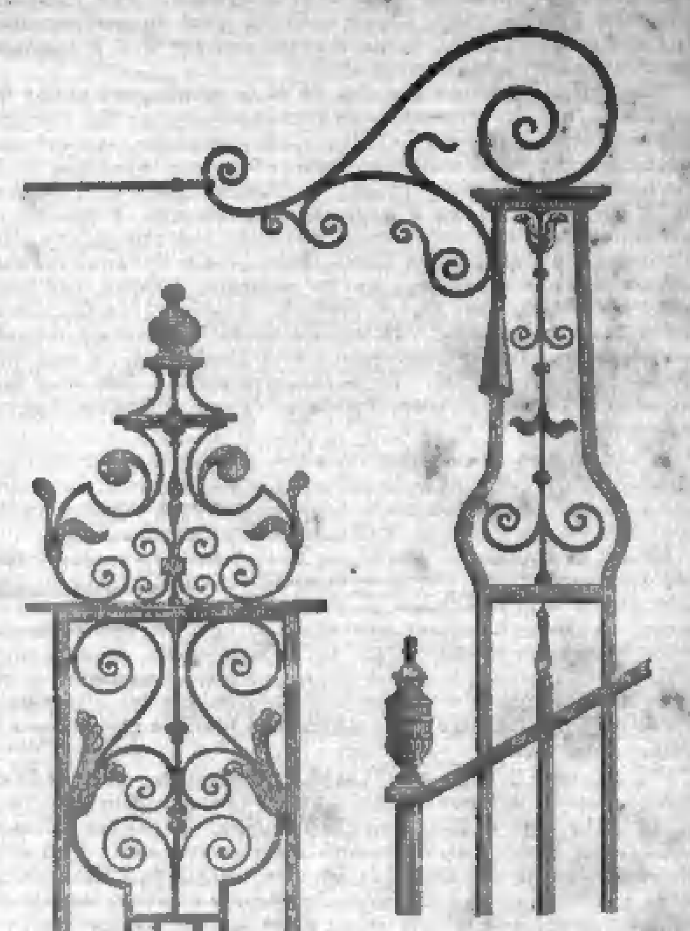


Fig. 2. Fig. 3.

It is singular sometimes to notice the influence of one form of improvement in superseding others; and little do we think, when contemplating and applauding progress, that we are likewise witnessing the first seeds of decay. There is, indeed, in things human, nothing without its alloy of evil; and we ought, therefore, always to be on our guard in all cases of innovation, lest we may, by adopting one new and good thing, destroy a still greater amount. In architectural matters this caution is particularly necessary, for the balance often is so very delicately held that the least change disturbs it. The consequence is, we have frequently, in our technical history, to notice the gradual decay of old processes in consequence of the extension of others. Thus, internal decoration has greatly suffered by the facility of moulding and reproduction; and wood carving, and ornamental ceiling work, are superseded by the repetition of composition and plaster patterns. Thus, at length we are obliged to regret we can no longer achieve, except with difficulty, the ornamental interiors of the Elizabethan or Jacobean period. In metal-work the same evil is felt. So long as the smith hammered out the details, a separate design was made for each work; but now that casting has become easy, and cast-iron cheap, design is virtually extinct in forged metal-work, and we are compelled to witness the rudest and most monotonous extensions of rails and spikes. The height of mischief once reached, regret is felt, and a strong desire evinced, if not to retrace our steps by giving up the cheaper material, at any rate to get back to good design. In the furtherance of this, nothing can be more useful than reference to good examples of the olden time; and we have therefore thought it worth while to give publicity to the accompanying sketches.

It will be noticed as the more strange that the decline has taken place when we have greater resources at our command, for the latent capabilities of iron were little imagined previous to the introduction of steam-engines, railroads, and machinery. Indeed, what would the artisans of a century and a-half ago say, could they behold the multiplied forms in which modern ingenuity has turned it to account? Now it is viewed as a valuable constructive material, of whose application every day furnishes fresh proof; then it was more usually a medium in which the cunning workman delighted to display his art, by fashioning it into those slender and graceful forms most generally adorning the lofty gates and railings of public buidings of that date.

Not a few of these tasteful specimens meet the eye of the inquirer as he lingers among the antiquated squares and once famous bye-streets of the metropolis or its vicinity; and we

do well to note their existence before the rage for novelty and the march of innovation have sacrificed them, like many of the edifices to which they were attached. Those which we give are as follows:—

Fig. 1, is one of the beautiful gates in the side portals to Inigo Jones's Church of St. Paul, Covent Garden. The design of this is easy and flowing.

Fig. 2, from the railing to a house in Great Ormond-street, Bloomsbury.

Fig. 3, a lamp-iron and link-extinguisher (mementoes of former customs) in Queen-square, Bloomsbury.

While we are upon this subject, we must express a further regret, and that is with regard to the retrogradation in the colouring of metal-work. Those who notice the beautiful gates of Holland Park, cannot fail to be struck with the successful application of painting and gilding in the decoration. These are made to harmonise well in the designs, and it should always be borne in mind in examining, copying, or applying old designs, that many of the thick parts are reduced by the application of light colours, and many of the slender parts are brightened by gilding. Now, one hue of black paint covers the metal surface; and, under some plea or another, gilding is abandoned altogether in exterior metal work, although the golden gallery of St. Paul's, the spires of our city churches, and the gates of Holland Park, show that it will stand well in our climate. Those who see the skilful and tasteful employment of gilding in the lampworks, railings, and gatework of Paris, always make an unfavourable comparison with London; and regret we are so neglectful of such resources. The railing of Mr. Hope's house in Piccadilly is a fine specimen of design and workmanship; but, for want of colour and gilding, it has an unfinished appearance.

THE EXHIBITION BUILDING.

(*With an Engraving, Plate X.*)

The roof of the building is rising above the ground, and fear for its well-ending is no longer felt: but another and a weightier task is hardly begun. We have called together the world; we have found room for all that may be brought; but we have yet to make ready what we ourselves may send. In making this call, we knew it was to those skilful and proud of their skill, and by them it has been answered. From France come twelve hundred, of whom one-third have already earned rewards at home. These are the cunning craftsmen who meet us with their wares at the ends of the earth. From the Prussian Rhineland alone two hundred and fifty come; from Switzerland three hundred—men who understand cheapness as well as ourselves, and who have sometimes overcome us on our own ground. It is to be hoped in the struggle now forthcoming, and before the eyes of the world, we may not be beaten, but we must not heedlessly rush on. Here, too, it must be borne in mind, there is a greater stake than that of the Commissioners, and that we must not look to the latter alone as answerable; and the rather as we have had good warning, they cannot be very heavily burthened. The fair name of England is at stake, and unless all put their shoulders to the wheel it may not be made good. To lean upon the Commissioners, and those under them, would be weakness, when it is ourselves to whom we must look.

The Royal Commission is set forth with great men; the local committees are not named by the working men but by the givers of money; and the local commissioners are named from the local committees. Thus there is a rooted evil; for what may be a very good body for getting money together, may be the very worst for the other work, of getting together the best things. Many held back from giving money who must be asked to send their goods, and they will not hold the gift of a pound or two as a worthier right than that they hold from the gifts of mind. This is the evil now working, and, unless timely help be given, the hoped-for end will not be reached. Abroad no bickerings of this kind can arise; they are older hands at this business, and better understand their work, and so we are threatened in the coming struggle in a two-fold way, by the skill of our foemen, and by their knowledge how to make the best of it.

From the shape of these Commissions and Committees another evil threatens to arise, and which shows itself in what they have as yet set forth, which is, that they will bring together a show of knick-knacks, and a gathering of what is old, common, and worn out, rather than what being new, skilful, and workmanlike, will best show our right to the great share we hold in the trade of the world. The whole business seems too much in the hands of bookmen, and of enlightened lords, colonels, and bankers, and too little in those of men having sound and working knowledge. This we feared from the first, and we are sorry we have been found aright, for this very thing stands more than anything in the way of the whole undertaking. Lords may smile, bankers may put down hundreds, but we shall make a sorry show of it, if we trust to them to set forth our mills and our workshops, to watch over the loom, or to seek out the lowly abodes of the earnest workmen, by whom so much of our trade is fostered and carried on.

We want neither a Conservatoire des Arts et Métiers, nor a Polytechnic Exhibition; we need not trust to knick-knacks, nor to out-of-the-way trumpery, to crowd the walls and fill the stands of the building, and awaken the wonder of the sight-seers; for there will be enough, and in good keeping with the greatness of the time, and of the building. There will be steam and water setting to work the several shapes in which man's skill has brought stiffened rods of brass and iron to weave more deftly than hands of living flesh—mighty bulks which work without thought better than thought can shape—elfins which work the behest of man, and cannot withstand his will. What the wildest thought has dreamed of in earlier days as beyond the reach of man will here be brought in wondrous fulness before our eyes.

What the *Times* says on this head is so striking, that we have thought it right to give at length.

"Not the least wonderful part (says the *Times*) of the Exhibition which is to be opened next year will be the edifice within which the specimens of the industry of all nations are to be collected. Its magnitude, the celerity with which it is to be constructed, and the materials of which it is to be composed, all combine to insure for it a large share of that attention which the Exhibition is likely to attract, and to render its progress a matter of great public interest. A building designed to cover 753,984 superficial feet, and to have an exhibiting surface of about 21 acres, to be roofed-in and handed over to the Commissioners within little more than three months from its commencement, to be constructed almost entirely of glass and iron, the most fragile and the strongest of working materials, to combine the lightness of a conservatory with the stability of our most permanent structures—such a building will naturally excite much curiosity as to the mode in which the works connected with it are conducted, and the advances which are made towards its completion. Enchanted palaces that grow up in a night are confined to fairy land, and in this material world of ours the labours of the bricklayer and the carpenter are notoriously never-ending. It took 300 years to build St. Peter's at Rome, and 30 to complete our own St. Paul's. The New Palace of Westminster has already been 15 years in hand, and is still unfinished. We run up houses, it is true, quickly enough in this country, but if there be a touch of magic in the time occupied, there is none in the appearance of so much stucco and brickwork as our streets exhibit. Something very different from this is promised for the great edifice in Hyde-park. Not only is it to rise with extraordinary rapidity, but in every other respect is to be suggestive of *Arabian Nights* remembrances. In its favour the window law is to be ignored, and 900,000 superficial feet of glass, weighing upwards of 400 tons, are to be used in its construction. Not a stone nor a brick will be employed throughout the spacious structure, which is to rest upon 3300 cast-iron columns, and to be strengthened and kept together by 2224 girders of the same material. The view of it which we now publish represents an edifice in every respect qualified to become the repository of specimens of the world's industry; the basement and two upper tiers diminishing in area as they ascend, and thus securing a graceful variety of outline, while the monotonous effect of a façade 1848 feet long is broken by a spacious transept. This transept, 408 feet long and 72 feet wide, will be arched, and will rise to the height of 108 feet, inclosing within it, as in a glass case, a row of trees, which respect for the park timber has induced the commissioners to spare. The roof of the entire building, resting on the cast-iron girders, will be what is technically called "ridge and valley," and will look like an undulating sea, the whole being covered with canvas to exclude the rays of the summer sun and prevent any inconvenience arising from excessive heat. This will be the case in every part of the structure except the transept, where the presence of trees render light necessary, and where, therefore, the arched glass roof will remain uncovered. When closed in and completed, the view presented by the interior will, it is anticipated, be wonderfully graceful and splendid. The central avenue, 1848 feet long, 72 feet broad, and 66 feet high, with rows of pillars shooting off from it

on either side, and so arranged that the eye can traverse freely to every part of the building, must have a very grand appearance. Care has been taken to have the columns upon which the whole fabric rests distributed with such regularity that no confusion or forest-like effect can be produced by them. It will be the same in all the avenues as in the central one, although there, from its proportions and the entire absence of galleries or upper flooring to break the perspective, the view presented will be most imposing.

Besides the immense space thus devoted to the general purposes of the Exhibition, there will be on the north side of the building a room set apart for the reception of machinery. The dimensions of this apartment are on a scale proportionate to the important branch of inventive industry to which it is to be dedicated. It will be 946 feet long, 48 feet broad, and 24 feet high. Another feature of the building will be the Refreshment Courts, which, in accordance with the aristocratic spirit of the country, are to be divided into three classes. Those whose means and tastes incline them to patronise the first will discuss the delicacies of the season under the branches of the trees which occupy the north end of the transept; those whose habits of life are less ambitious, or whose palates are less discriminating, must move westward; while for the crowd of humble visitors the requisite accommodation will be provided on the north-east side of the building.

To enter into further details with reference to the interior plan would needlessly complicate this description, and would be inappropriate at present. It may, however, be right to mention that while from north to south and across the breadth of the structure the flooring will be perfectly level, from west to east it will be slightly inclined, like the stage of a theatre, though not of course to the same extent. This, it is believed, will add much to the effect of the interior, by enabling visitors at the lower end to see almost at a glance over the whole edifice. Though from north to south the flooring will be quite horizontal, the land slopes a little, and this enables the architect to give the building on that side the appearance of a raised foundation, which will be faced with green sod. The advantage of this to the external beauty of the principal façade it is almost unnecessary to point out. A light iron railing will inclose the building at a distance of 8 feet from its exterior, and beyond that will be a footpath. The grand entrance will be nearly opposite the Prince's gateway, and will have seven pairs of doors. Ample arrangements have been made, however, for the entry and exit of visitors at other points. The exterior surfaces of the first or ground tier will not be of glass, but of wood, for the purpose of greater security, and also to afford a wall space for such articles as require to be hung up in order to be seen to advantage. To enumerate in detail all that this great undertaking embraces would be an endless and perhaps rather a tedious task, but some conception of the work to be performed may be gathered from this—that the calculations of Messrs. Fox, Henderson, and Co., the contractors, estimate, among other requisites, 34 miles of gutters, 202 miles of sash bars, and 8 miles of table for exhibiting.

Turning from the building as it is to be to what has already been performed, it will be found that considerable progress has been made. It is now a month exactly since the actual work of construction commenced. In that time the foundation pieces on which the columns rest have nearly all been fixed upon their beds of concrete, and the earth filled in around them. The columns required for a large section of the southern and central parts of the building have been put up and connected together by girders. The framework begins to indicate the form of the future structure, just as the ribs and bones of the mammoth at the British Museum shadow forth what the animal must have been when alive. The graduated outlines of the structure ascending tier above tier, the cathedral-like effect of the transept, and the long-extended avenues and rows of slender pillars, branching off symmetrically on either side of them, can already be discerned. Sleepers and joists for the flooring have been laid in one or two parts, and one small piece of window framing has been fixed in its place. The external facing of the ground tier has been commenced, and while the framework of about one-third of the structure is in a forward state nearly every detail of the work has been begun. Messrs. Fox and Henderson have already one small crane established on the girders for hoisting up materials, and in a few days they will have several more. The rapidity with which the building progresses may be estimated from the fact, that two columns and three girders can be fixed in about 15 minutes. While the actual labour of construction proceeds, a vast amount of preparatory work goes on simultaneously. Nearly all the wooden arches required to span the transept are completed. Sash bars, window frames, intermediate bearers and gutters, are got ready by hundreds of workmen under sheds, formed hastily of floor planking. The hydraulic press is at work testing the strength of girders, and a few fires are lighted to prepare the wrought-iron bolts by which the columns are made fast to the connecting pieces between them. Piles of materials of every kind are collected in every part of the ground, and it is believed that three-fourths of all that will be required are already deposited within the hoarding. There is a stable for 20 horses, which are employed in drawing. At present 900 hands are at work within the inclosed space, but it is estimated that the number must yet be raised to 1500. No difficulty is found by the contractors in procuring the requisite supplies either of material or labour. The iron work is all brought from Birmingham, where it is prepared by Messrs. Fox and Henderson, assisted by two other houses. One firm furnishes the whole amount of glass required. The timber used is from the Baltic, and of excellent quality. A portion of it is prepared at mills taken for the purpose at Chelsea, and the rest on the grounds. When the weather is wet, this part of the work, which is carried on under cover, is pushed forward. When it is dry the fixing of columns and girders is proceeded with. Gas has been laid on in the grounds, and the toils of the day are continued frequently as late as 11 o'clock at night. Within a commodious set of offices the heads of departments regulate the work and prescribe the division of labour to be pursued. Here, too, a room has been established for draughting plans of the building, in conformity with which it is to be completed. A considerable portion of the work is done by the *piece*, and no difficulty is found in procuring any amount of hands that may from time to time be required. Every morning they assemble in great numbers at the entrance ready for employment, and when engaged they turn out very efficient workmen. Such a supply must be regarded as one of the most important facilities which a great city like London presents for the execution of an undertaking like this. An ingenious system of checks by means of variously shaped brass tokens has been introduced to determine the number of hours per day for which each man has been occupied, and the remuneration to which he is entitled. The whole business of the contractors seems to be carried on the most systematic and orderly manner; and what is very remarkable is the little noise or bustle with which the work proceeds. When the materials of which the building are chiefly composed are recollected this will be the more easily understood. Nearly everything is brought on the ground ready to be put up, and the loudest sound that reaches the ear is the occasional clink of a hammer 'closing rivets up.' Over so large a space the noise of labour is lost, and the building ries almost as silently as did Solomon's temple.

The contractors still speak with perfect confidence of their ability to construct and roof-in the whole before New Year's-day. They have within the last month done a good deal, but in the two that still remain to them they will find their energies fully taxed to do all that still remains to be accomplished. If within the limits of time prescribed to them they succeed in carrying out so extensive and elaborate a plan as that which they at present contemplate, they will merit the utmost praise; but before even the letter of their contract the safety of the public must be placed, and we do trust that every precaution will be adopted to prevent the possibility of accidents hereafter. Of late years many circumstances have occurred to shake the confidence which was at first reposed in iron structures. Suspension bridges and railway terminal have been giving way and falling in from comparatively slight causes—the smallest defect in a part, the snapping of a rod, or the shaking of a pillar, by disturbing the distribution of forces, often brings down the whole fabric. The new building in Hyde-park is a novelty in architecture—and a novelty upon a grand scale. It is to be provided with many galleries, where specimens of industry will be exhibited, and where, therefore, crowds of visitors will assemble to inspect. Considering the materials used, therefore, it is most important that every care should be taken to insure the safety of these galleries. Messrs. Fox and Henderson say that they have adopted every precaution in this respect, and that their calculations of strength are such as to render an accident from the crowding of spectators impossible. We trust that it may be so, and we think it due to them to state that a minute examination of the progress already made in the work has impressed us with a high sense of the efficient, orderly, and expeditious manner in which it is carried on. This is the more remarkable when the novel character of the structure is remembered, that novelty removing it out of the routine habits of those engaged in the labour of construction."

IMPROVEMENTS OF THE RIVER SEINE.

Some very important works are in progress at present upon the river Seine, for the improvement of the navigation of that river, a succinct account of which is appended.

The Seine has a very long devious course, principally through a valley in the tertiary limestones of the Paris basin, and through the chalk between Mantes and the sea. It is very subject to floods in the winter and spring, which come down from the hills of Burgundy with considerable violence; whilst in the summer it is often so low that, as in 1842, the navigation by barges drawing 4 feet water is suspended. The tide runs to a little beyond Pont de l'Arche, a distance of perhaps 60 miles.

Owing to the configuration of the embouchure a bar is formed at Quillebœuf and Tancarville, at a point where the river—which had previously spread out on both sides over a flat alluvial plain, sometimes bare at high tides—is contracted between two advancing spurs of the chalk formation. Formerly the regime thus superinduced was such as to give rise to a "bore" of about 3 to 4 feet high occasionally; but at neap tides there was never enough water on the bar to allow a 400 tons' burden ship to mount the river, although directly the stream became narrowed above Villequier, sufficient depth to float even a 1000 ton ship existed at high tides.

The objects proposed then were to deepen the river so as to allow large vessels to reach Rouen, and to establish such a system of locks, &c. in the upper portion, as to ensure a constant depth of 6 ft. 6 in. in the driest seasons as far as Paris. The works already executed have succeeded most remarkably in the attainment of these objects as far as they bore upon them. They are as follows:—

Tidal Portion.—Up to August, 1850, they had been confined to the embankment of the river between Candebec to Villequier and Quillebœuf, by means of rubble-stone embankments of a length of 16,000 mètres on the right bank, and of 9600 on the left bank. At the point where the works commenced the channel was made 300 mètres (1000 feet) wide; and it was augmented 10 mètres in a kilomètre, or in the ratio 1 : 100 to the embouchure. The concave embankment was found to require twice as much stone as that upon the convex side, the former taking 100 mètres cube, the latter 50 mètres cube, per mètre forward.

The result has been to deepen the river 2·80 mètres (a little more than 9 feet). The "bore" has disappeared in the parts regularised; the length of the duration of the flood tide increased one hour; the still water, or dead tide, has also gained a quarter of an hour. The flood would be sent much further up the country did not the stone thrown to protect the feet of the piers of the Manoir Bridge, on the Rouen and Paris Railway, act as a dam to keep it back. It is probable that the result of the works in the river upon this bridge will be to throw it down.

The total cost of the embankments has been hitherto 2,310,000 francs, or 92,400*l.* sterling, being at the rate of 3 francs the mètre cube of stone in place.

To complete the project, it would be necessary to execute above Candebec and la Meilleraie 5,122 mètres of embankment on the right, and 6,700 upon the left shore. Below Quillebœuf it is proposed to continue the channel through the sandbanks of the embouchure, by the execution of 12,540 mètres on the right bank, and 9600 upon the left.

Natural Water Course above Tides.—The system adopted for the attainment of the depth required in this portion, has been to erect a series of barrages or weirs upon the river, so as to divert the water into the arm rendered navigable, and to leave an overflow under the control of the lockman at the head of the pond or reach.

The weirs are formed according to the plan so successfully applied by M. Poirée at Bezons, consisting of a series of wrought-iron frames with wooden blades to close the openings, fixed by hand; the wing walls are in stone, and dressed off at a level to allow any flood-water to overflow at 6 inches above the depth required in the lock, should any sudden flood come down by night. The locks are made 120 mètres long by 12 mètres wide (400 feet by 40 feet), and a fall of 2 mètres, or 6 ft. 7 in. nearly.

Originally it was proposed to form at least ten of these barrages. The first is formed in Paris itself, and is actually in course of execution; the river is being inclosed to a width of 32 mètres in the narrowest part, beginning from the extremity of the Isle de la Cité, and terminating at the extremity of "terre Plein" of the Pont Neuf. The wing walls of the dam are dressed off at a height to secure 2·16 mètres water; the barrage is meant to heap them up to 2·26 mètres; but of course before arriving at this height, some of the blades would be drawn. Quay walls and roads, with inclined approaches from the upper level, are being formed; a large culvert, 2·50 mètres wide by 2·50 mètres from invert to key, is also constructed to take off the lateral sewers to a level below the locks. These works are estimated to cost 200,000*l.* sterling.

Connected with these works may be cited the lowering of the roadway of the Pont Neuf, to cost 72,000*l.* The old arches are cut away where necessary, and replaced by new arches of an elliptical form, the space between the new and old work, where any exists, being filled-in with hydraulic lime concrete. The scaffolding employed is very remarkable, being in fact a suspension scaffolding, hanging from the turrets on the piers of the bridge. Indeed, it would be impossible to imagine how works could be so carefully, so perfectly, and so elaborately executed, as all these are, unless by French engineers, working with government money.

Other barrages have been executed at Bezons, Andrésy, and Vernon; one at les Poses, near Pont de l'Arche, is in course of execution. Barrages are to be formed immediately at St. Ouen Meulan; others are proposed at Surcsnes, Maisons, Triel, and perhaps others below Meulan.

The barrage executed at Bezons, at a cost of 80,000*l.*, gave a sur-elevation of 1·20 mètres (4 feet) at a distance of 7½ miles from the locks, the fall of the river being on the average 0·10 per kilometre, or 1 in 10,000. The heaping-up of the waters by the barrage of Andrésy is felt in the Seine and Oise, at a distance of 20 kilometres, or 12½ miles.

At some future day I will send you drawings of the barrage of Bezons, which will illustrate the very simple, but efficient means employed on this river, to canalise it completely.

Geo. R. Burnell.

Southampton, Oct. 23rd, 1850.

PUBLIC WORKS AT ALGERIA.

The East India Company have at length roused themselves from the state of inaction they so long preserved in the execution of railways and other communications in their immense possession. It is better late than never. But to enable your readers to compare the conduct of a government managed under the direct control of a representative assembly, with that of the anomalous body known in India as the Coompani Jehan, I have the honour to inclose you a condensed statement of what has been done by the French government in Algeria since their occupation in 1830.

It is to be observed, that we are far from wishing to hold up the colonial government of our neighbours as a model in all things; but the care they have taken in the execution of means of communication between the different points of their still very precarious possession, may well merit our serious consideration.

In the report from the Minister of War to the Legislative Assembly, in the spring of 1850, it is stated that, subsequently to the occupation of Algeria, there have been executed in that colony, at the expense of the mother country, no less than 3970 miles of road; 18,959 acres of marsh lands have been drained; 278,000 yards linear of irrigation channels; and 82,057 yards of main drains or ditches; and 127,000 yards of aqueducts or water courses have been constructed; 91,900 yards linear of street have been formed or regularised in the divers towns; and nearly 32,000 yards linear of sewers formed in them; barracks have been erected for 40,000 soldiers, and hospitals for 5000 invalids. The port of Algiers has been improved, and important works begun at several other points on the coast. Churches for the Christian population, mosques for the indigenous races, have been restored, and new ones built where needed.

The country in which these works have been executed is only 77,120,000 acres superficial (France itself being 131,966,525 acres nearly), including the Little Desert, which occupies above two-thirds of the surface. The densely-peopled portions are the civil territories of the Prefectures of Algiers, Oran, and Constantine, whose total surfaces are only 706,902 acres. The population in 1848 consisted of 64,123 Frenchmen, 55,141 other Europeans, mostly Maltese, Spaniards, and Sicilians. The different sexes and ages are—men, 49.839; women, 34,937; children, 34,488. The indigenous population is supposed to be three millions; and the army of occupation 60,000 men.

Has our occupation of India produced equal advantages to the native tribes? Have we done so much to assist their advance in civilisation? If not, have we not rather abused our strength than fulfilled the duty our superior intellectual position imposes on us; and shall we not suffer the penalty sooner or later? A foreign nation never can retain possession of another country, unless it secure to its subjects a greater amount of happiness and prosperity than it could procure itself. Doubtlessly, the native kings of India did less for their subjects than the Company has done; but the example of the French government would lead us to question whether we have fulfilled our whole duty. There are in India far less artificial means of communication than there are in Algeria. Yet what are the relative populations, surfaces - and especially, what are the revenues obtained in the respective cases? For it is to be observed, that Algeria has cost France at least four millions sterling per annum for the last 20 years, whilst India yields a large sum to be divided amongst the share or bondholders every year.

GEO. R. BURNELL.

Southampton, Oct. 23rd, 1850.

VENTILATING APPARATUS.

In No. 152 of the *Journal* (p. 145), we pointed out the efficient internal arrangements of the York County Lunatic Asylum, of which we gave the plans and elevation. Among these arrangements, which we could not then particularly describe, is the ventilating apparatus, which was exhibited to several architects and men of science at the warehouse of Messrs. Baily, ironmongers, High Holborn. This apparatus is constructed under the directions of Dr. Arnot, and was explained by him to Lord Wriothesley, Sir Thomas Deane, Dr. Ure, Professor Donaldson, Mr. Fowler, Mr. Godwin, Mr. Laxton, and some other gentlemen. Those who know the enlightened, energetic, and disinterested efforts of Dr. Arnot for the extension of mechanical appliances in aid of hygienic science, will not fail to receive with pleasure this new application of his ingenuity. The water-bed, much as it may be justly esteemed by medical men, is no less an admirable exemplification of mechanical skill in the adaptation of simple means. The apparatus which we are now about to describe, is likewise very simple, and at the same time promises to be very effective.

The apparatus is shown in the annexed engravings, of which fig. 1 is a plan and fig. 2 a section, taken through the centre from A to B. It consists of a fixed cylinder, placed in the centre of a room, and which cylinder is about 5 ft. 6 in. diameter and 5 ft. high; with a chamber above and below, each furnished with inlet-valves to receive the air from the fresh-air shaft, and outlet-valves to deliver the air into the adjacent chamber, and thence distributed through the building. The cylinder is made of galvanised iron, is open at both ends, and has an outer case at about 3 inches distance, and the whole depth of the cylinder filled with water, which forms an annular hydraulic joint. Within this cylinder is another cylinder, 5 ft. 9 in. diameter, inclosed on the top, similar to the rising bell of a gas-holder; the rim of this cylinder works up and down in the water contained in the annular rim just described. By this arrangement the communication with the upper and lower compartments is cut off.

The working cylinder is suspended to the end of a moveable beam about 10 feet long, and balanced by a weight or bob suspended to the other end, equal in weight to the moveable bell, minus a sufficient weight to cause the bell to descend and expel the air in the lower compartment. Now, for the purpose of setting the beam in motion, it is necessary to have some moveable power to overcome the friction of the moveable parts and the air. For this purpose Dr. Arnot has adopted a single-action water-engine, having a cylinder 2 inches diameter and 12 inches stroke; to be supplied by water from a reservoir placed on the top of the building, 60 feet above the engine. A column of water of this altitude acts with a pressure of about 30 lb. on every moveable square inch of the piston; and if the piston be 2 inches diameter, it will be equal in round numbers to 3 square inches, consequently the force of the water acting on the piston will be $3 \times 30 = 90$ lb.; and this is the power with which the Doctor proposes to work the apparatus, and as the engine is single-acting, the cylinder will require about a pint of water for every stroke. Thus, if the engine works 8 strokes per minute, it will require 8 pints of water, or 1 gallon per minute, to keep the beam moving.

This engine is placed so that the connecting-rod is connected with the moveable beam at 1 foot from the fulcrum; and if the beam have a radius of 5 feet, and the working cylinder be suspended at the end of the beam, the bell will be elevated 5 feet at every stroke of the engine. When the piston has performed one upward stroke by the pressure of the water, the water is cut off by a slide-valve, and that which is within the cylinder is discharged into an open pipe; consequently, the extra weight of the moveable parts will cause the piston to descend, and at the same time the working cylinder will also descend. Now, if we suppose that at the commencement of the working of the apparatus the working cylinder is close down on to the fixed cylinder, the upper compartment will be filled with air, and as it rises it will displace a quantity of air equal in capacity to the cubic contents of the working cylinder, and force it out of the valves that open outwards; and at the same time that the cylinder is rising, the space below is increasing equal in capacity to the cylinder, and a quantity of air rushes in through the valves opening inwards, and fills up the space; and when the bell begins to descend, the lower inlet-valves close and the lower outlet-valves open, and the air that is below is forced out through the outlet-valves of the lower compartment, and at the same time the air is being admitted into the upper compartment, as before described. By this means the action is double, and a constant stream of air is being taken in through either of the inlet-valves, and forced out through the upper or lower outlet-valves into the adjacent chamber, and thence through trunks and cases to all parts of the building.

Now, it has been shown, that for every stroke of the engine the working cylinder displaces a quantity of air equal to its capacity in both the bottom and upper compartments; and as the capacity of the working cylinder is equal to 125 cubic feet, it displaces in both compartments 250 cubic feet for every upward and downward stroke of the engine, at an expense of one pint of water, descending from an altitude of 60 feet; and if the engine works 8 strokes per minute, it will displace 2000 cubic feet of air, at an expense of 8 pints, or one gallon of water, which is equal to 2,880,000 cubic feet of air, displaced by the aid of 1440 gallons of water for 24 hours. These are the proportions proposed by Dr. Arnot for ventilating York Hospital.

For the purpose of feeding the apparatus, pure air is brought down a shaft, the top of which is considerably above the top of the building, and which communicates at the bottom with the chambers before described; and if it be desired that the air be warmed, it is effected by allowing the air, as it is expelled from the chambers, on its passage to the trunks, to pass between a series of hollow copper vessels filled with hot water.

The adaptation of the water-engine, which Dr. Arnot proposes to adopt, is particularly desirable, as it can be worked at comparatively little expense, and the water, after it has done its work in the engine, may be used for domestic purposes. It will also be seen that by this apparatus the whole of the air forced in for ventilation can be accurately measured if a counter be attached to the engine to show the number of strokes the engine has performed during the day.

Reference to Engravings.

Similar letters refer to similar parts in each figure.

A, is a fixed cylinder, open at both ends with outer case *a*, filled with water, forming an annular hydraulic joint.

B, working cylinder inclosed on the top and open at the bottom; the rim works up and down in the hydraulic joint *a*.

C, C', upper and lower chambers, with inlet valves *iv*, opening inwards to take in the air from the external air-shaft E; and outlet valves *ov*, opening outwards to convey the air to the shaft D, and thence to the building through the trunk T.

F, furnace-room, in which is placed the boiler with four square fire-boxes *f, f, f, f*, to heat the water for supplying the copper cells *g*, when it is required to warm the air as it is being forced into the building; there are several of these copper heating cells placed side by side, with narrow spaces between for the air to pass through.

H, a water-engine, acted on by a column of water on one side of the piston, which is brought by a pipe *h*, from a cistern placed on the roof 60 feet above; *j*, is an air-vessel to prevent concussion by cutting off the water suddenly; *k*, gear for opening and shutting the eduction and induction valves; *l*, piston and connecting-rod.

K, balance-beam; at one end is fixed a chain to suspend the working cylinder, and at the other end is another chain to suspend a balance-weight *m*.

VENTILATING APPARATUS.

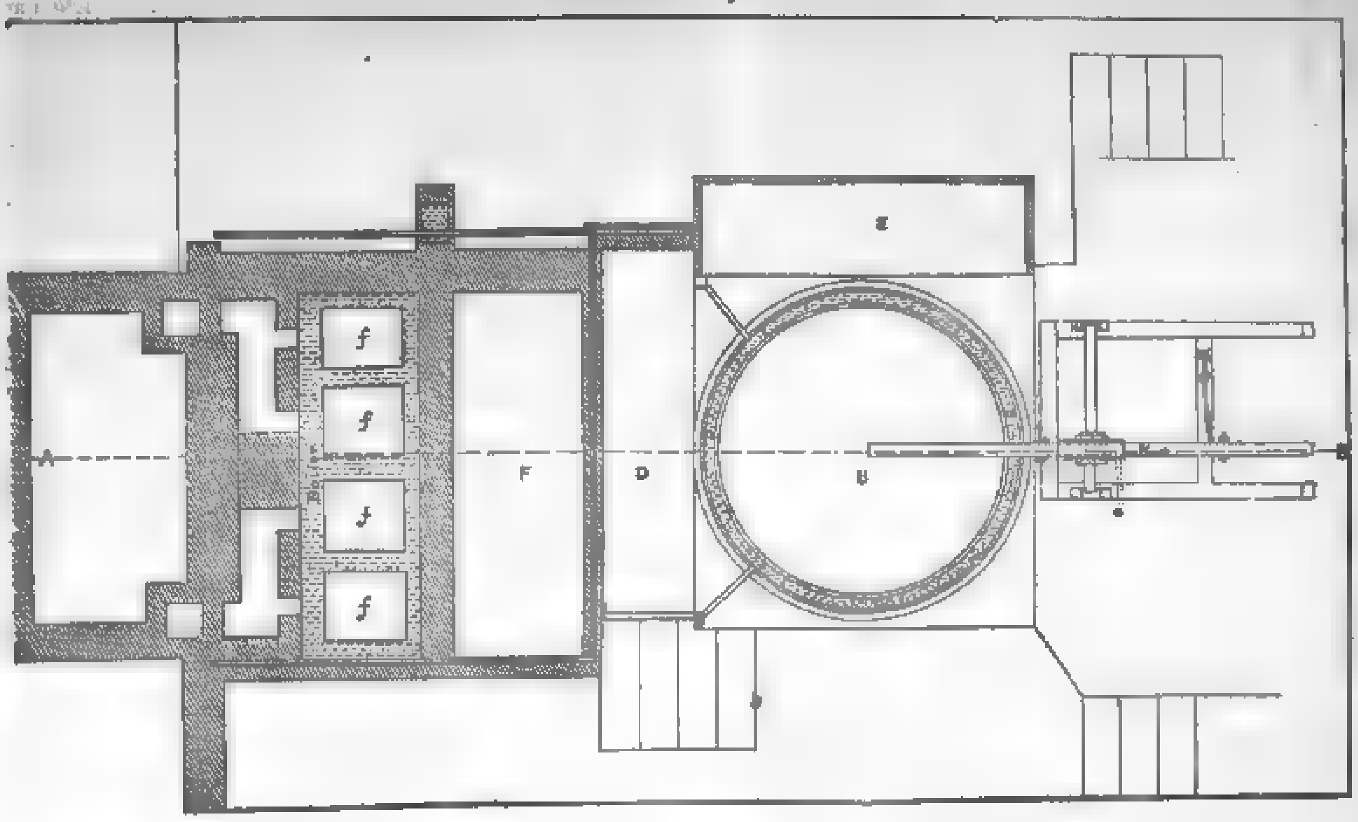


Fig. 1.—Plan.

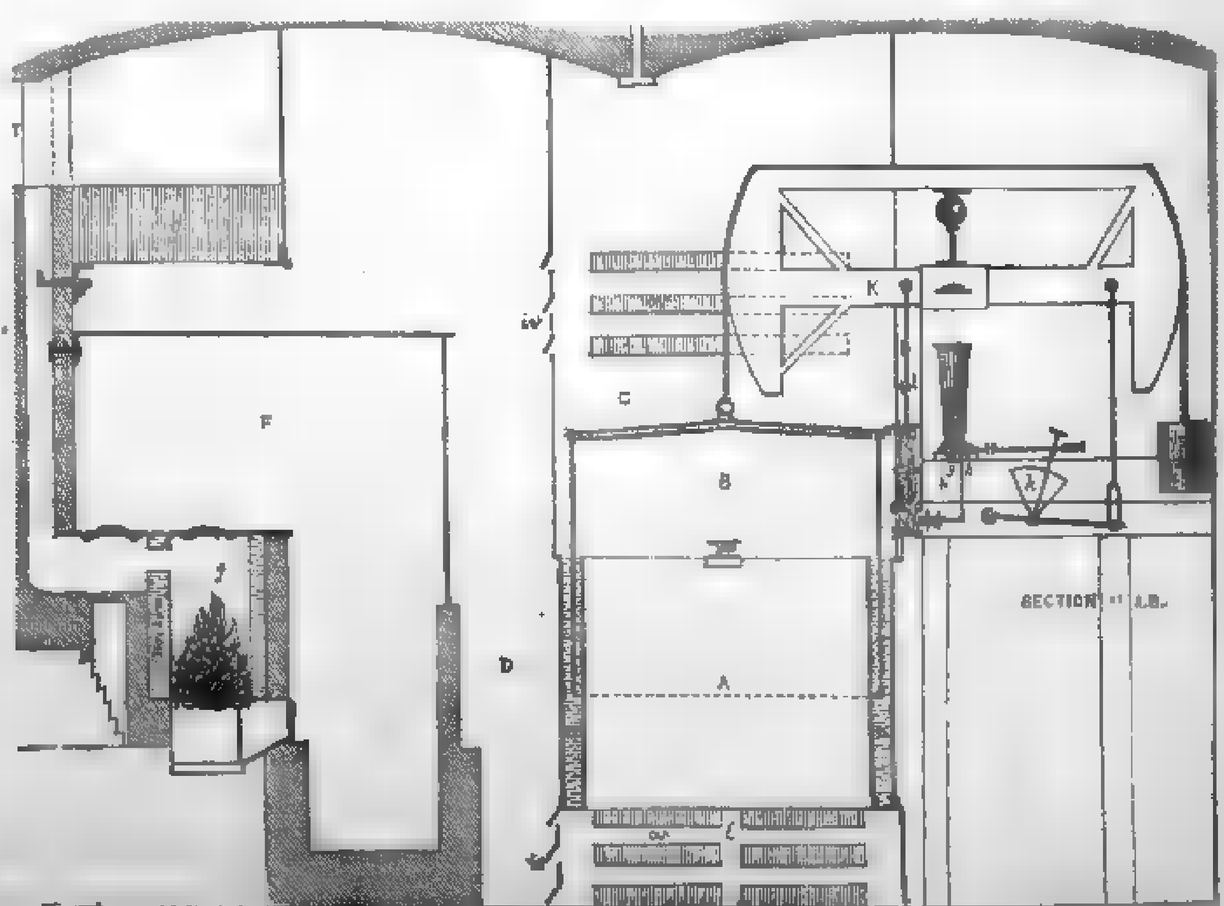


Fig. 2.—Section.

EARTHWORK CALCULATIONS.

On the Calculating of Earthwork. By James Henderson, C.E., Glasgow.

In the calculating of earthwork, where the base and slopes are regular and uniform, as in the case of railways, roads, &c., the following short table I have found both useful and expeditious:

No.'s Feet.	Centre.	Sides.	Difference.	No.'s Feet.	Centre.	Sides.	Difference.
1	2·4	2·4	·2	26	63·5	1652·4	137·7
2	4·9	9·8	·8	27	66·0	1782·0	148·5
3	7·3	22·0	1·8	28	68·4	1916·4	159·7
4	9·8	39·1	3·3	29	70·9	2055·6	171·3
5	12·2	61·1	5·1	30	73·3	2200·0	183·3
6	14·7	88·0	7·3	31	75·8	2349·1	195·8
7	17·1	119·8	10·0	32	78·2	2503·1	208·6
8	19·5	156·4	13·0	33	80·7	2662·0	221·8
9	22·0	198·0	16·5	34	83·1	2825·6	235·5
10	24·4	244·4	20·4	35	85·5	2994·4	249·5
11	26·9	295·8	24·6	36	88·0	3168·0	264·0
12	29·3	352·0	29·3	37	90·4	3346·4	278·9
13	31·8	413·1	34·4	38	92·9	3529·8	294·1
14	34·2	479·1	39·9	39	95·3	3718·0	309·8
15	36·7	550·0	45·8	40	97·8	3911·1	325·9
16	39·1	625·9	52·1	41	100·2	4109·1	342·4
17	41·5	706·4	58·9	42	102·7	4312·0	359·3
18	44·0	792·0	66·0	43	105·1	4519·8	376·6
19	46·4	882·4	73·6	44	107·5	4732·4	394·4
20	48·9	977·8	81·5	45	110·0	4950·0	412·5
21	51·3	1078·0	89·8	46	112·4	5172·4	431·0
22	53·8	1183·1	98·6	47	114·9	5399·8	450·0
23	56·2	1293·1	107·8	48	117·3	5632·0	469·3
24	58·7	1408·0	117·3	49	119·8	5869·1	489·1
25	61·1	1527·8	127·3	50	122·2	6111·1	509·3

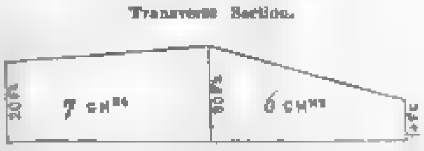
Rule. To the quantity in column of Sides, corresponding to the mean height in column of No.'s, add the quantity in column of Difference corresponding to the difference of heights in column of No.'s, and multiply the sum by the length of cut or bank in chains; and that product by the slope of banks, for the cubic yards in sides of said cut or bank.

Again, multiply the quantity in column of Centre, corresponding to the mean height in column of No.'s, by the length of the cut or bank, in chains; and that product by the breadth of base, in feet, for the cubic yards in centre of said cut or bank.

The sum of these two quantities gives the total cutting or banking, in cubic yards.

Example.

Transverse Section.



Longitudinal Section.

Lengths.	Mean and difference of heights.	Centre.	Sum of sides and difference.	Product of centre and lengths.	Product of sum of sides and difference into lengths.
7	25 / 10	61·1	1527·8 + 20·4 = 1548·2	427·7	10837·4
6	22 / 16	53·8	1183·1 + 52·1 = 1235·2	322·8	7411·2

750·5	18248·6
30	1½
22515·0	18248·6
	9124·3

Sides . . 27372·9
Centre . 22515·0

Total . . 49887·9 cubic yds.

The principle on which this table is based is—That the difference between the true contents of the sides of a cut or bank and the contents found by taking the mean section, varies as the square of the difference of heights; the true contents more or less exceeding the contents obtained by taking the mean section as the difference of heights is more or less. In table, the quantities in column of Sides are the contents of sides by taking the mean section, and the quantities in column of Difference those required to be added in order to obtain the true contents. In Bidder's table for calculating earthwork, the true contents of sides are given for every variation of mean and difference, which consequently causes a very large number of different quantities in table; so much so, that if, instead of being carried out every foot in height to 40 feet, it were carried out every tenth of a foot to 50 feet, it would occupy a good-sized volume; while, by keeping the difference separate, as in the above table, the same could be comprehended within a few pages, and be less complicated.

In this, as well as in Bidder's table, the contents are correct only when the ground is uniformly level transversely; but, as the surface is generally more or less sloped, it becomes important to ascertain the additional quantity required to be added in order to obtain the true contents.

Take C = contents as found by the former table; B = ½ of base in feet; L = length of cut or bank, in chains; S = slope of banks; and T = tabular number corresponding to the slope of banks and surface of ground, as given in the adjoining table. Then, $\left(C + \frac{22 . B^2 . L}{9 . S}\right) \times T$ = additional quantity required to be added to contents C, in order to obtain the true contents.

Slope of ground.	Slope of banks.	
	1½ to 1	2 to 1.
1 in 5	·0989	·1904
" 10	·0230	·0416
" 15	·0101	·0181
" 20	·0056	·0101
" 30	·0025	·0044
" 40	·0014	·0025
" 50	·0009	·0016
" 60	·0006	·0011
" 70	·0004	·0008

Example. Suppose that in the former example the average slope of the ground was 1 in 10. Then,

$$\left(49887·9 + \frac{22 . 15^2 . 13}{9 . 1\frac{1}{2}}\right) \times ·023 = 1257 \text{ cubic yards,}$$

which, added to 49887·9, gives 51144·9 cubic yards for the true contents of cutting.

SYMMETRIC PROPORTION.

On an Application of the Laws of Numerical Harmonic Ratio to Forms generally, and particularly to that of the Human Figure. By D. R. Hay, Esq.—(Paper read at the Royal Society of Edinburgh.)

The author stated in some prefatory remarks, that a belief in the operation of the laws of numerical harmonic ratio in the constitution of beautiful forms had long existed, although those laws had not been systematised so as to render them applicable in the formative arts. In proof of this, Mr. Hay quoted a correspondence upon the subject of harmonic ratio, between Sir John Harrington and Sir Isaac Newton, in which the latter expresses his belief in such laws in the following words: "I am inclined to believe some general laws of the Creator prevailed with respect to the agreeable or unpleasing affections of all our senses; at least, the supposition does not derogate from the power or wisdom of God, and seems highly consonant to the simplicity of the macrocosm in general." The belief of this great philosopher, the author trusted, would form some apology to men of science for the repeated attempts he has made to establish the fact. These attempts he had hitherto made with reference to architecture, to ornamental design, and latterly to the human head and countenance; but on the present occasion he intended to show the operation of these laws in constituting the symmetrical beauty of the entire human figure.

He next proceeded to point out the remarkable similarity that

exists in the physical constitution of the organs of hearing and seeing, and the manner in which external nature affects the sensorium through these organs; showing the difference between noises and musical sounds in the one case, and irregular and regular forms in the other. He explained that each musical sound was produced by a number of equal and regular impulses made upon the air, the frequency of which determining the pitch of the sound; their violence its loudness; and the nature of the material by which the impulses were made its quality or tone. In like manner, he showed that the effect upon the optic nerve produced by external objects is simply that of the action of light, and amenable to the same laws. Variety of form being analogous to variety of pitch; variety of size to that of intensity or loudness; and variety of colour to that of quality or tone.

Mr. Hay next explained the nature of the harmonics of sound, which result from the spontaneous division of the string of a monochord by the formation of nodes during its vibratory motion. He then showed how the harmonics of form could be evolved from the quadrant of a circle by the following process:—

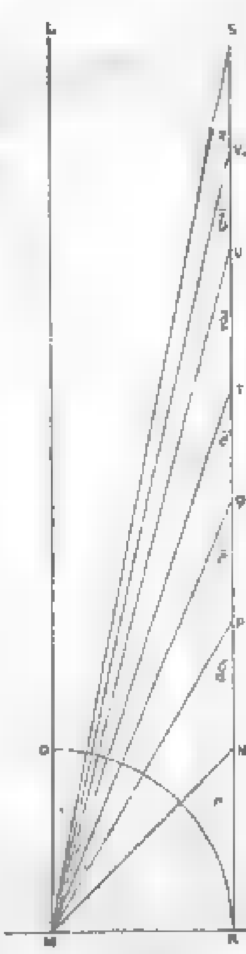


Fig. 1.

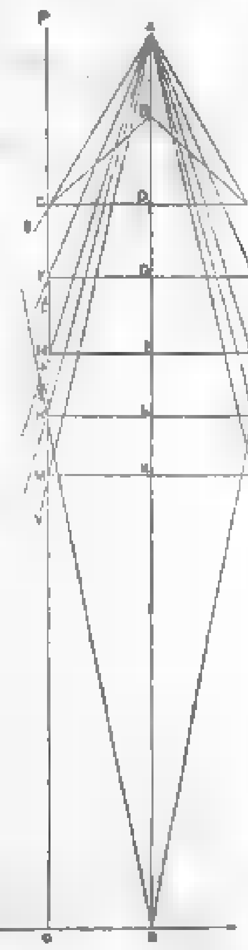


Fig. 2.

From a horizontal line MR, fig. 1, he produced two parallel vertical lines ML, and RS, indefinitely, and with a radius MR described, from the centre M, the quadrant OR. From O, he divided the arc of the quadrant into parts of $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, $\frac{1}{7}$, and $\frac{1}{8}$. From the centre M, and through these divisions, he produced the lines MN, MP, MQ, MT, MU, MV, and MS, until they met RS, forming the right-angled triangles MPR, MQR, MTR, MUR, MVR, and MSR. He then showed, that as the angles at the vertex of each of these triangles, contained respectively 45°, 30°, 22°, 30', 18°, 15°, 12°, 51', 26", 11°, 15', they related to the right angle, as the harmonics of sound, expressed by the signs c, g, $\bar{c}$, $\bar{e}$, $\bar{g}$, $\bar{b}$, and $\bar{\bar{c}}$, relate to the fundamental note C, produced by the string of the monochord. These triangles he combined in the following manner upon a line AB, fig. 2, which he said might be of any given length according to the size of the figure to be formed. From B, at an angle of 11° 15' with AB, he drew the line Bg, indefinitely, and from A at an angle of 15° with AB the line Ar also indefinitely, and cutting Bg, in K. Through K, he drew KL at right angles with AB, forming the triangles ALK and KLB. Through K he drew the line *p*O parallel to AB. From A at an angle of 12° 51' 26" with AB he drew AV, cutting *p*O in M, and drew MN at right angles with AB, forming the triangle AMN. From A at an angle of 18° with AB, he drew A*u*, cutting *p*O in H, and drew HI at right angles with AB, forming the triangle AHI. From A at an angle of 22° 30' with AB, he drew A*t*, cutting *p*O in F, and drew FG at right angles with AB, forming the triangle AFG. From A at an angle of 30° with AB he drew A*s*, cutting *p*O in C, and drew CD at right angles with AB, forming the triangle ACD. From C at an angle of 45° with AB and CD he drew CE, forming the triangle CDE. Thus, he observed, were the triangles arising from the harmonic angles constructed upon AB in the same relative proportions to each other, that they were when formed upon the line RS, fig. 1. Upon the other side of AB he constructed similar triangles forming the equilateral triangle ACC; the right-angled isosceles triangle ECC, and the acute-angled isosceles triangles AFF, AHH, AKK, AMM, and BKK. Within this diagram he showed that the human skeleton could be formed in the most perfect proportions, determining, at the same time, the centres of all the various motions of the joints; and also that the symmetrical beauty of the external form, whether in a front or profile view, was governed by these angles; thus endeavouring to prove that an application of the laws of numerical harmonic ratio in the practice of the sculptor and painter would give these imitative arts a more scientific character than they at present possess, and, so far from retarding the efforts of genius, would rather tend to facilitate and assist them.

Professor Kelland's *Exposition of the Views of* D. R. Hay, Esq., *on Symmetric Proportion.*

The fundamental hypothesis of the author was stated to be this:—That the eye is capable of appreciating the exact subdivision of spaces, just as the ear is capable of appreciating the exact subdivisions of intervals of time; so that the division of space into an exact number of equal parts will affect the eye agreeably in the same way that the division of the time of vibration in music, into an exact number of equal parts, agreeably affects the ear. But the question now arises—What spaces does the eye most readily divide? It was stated that the author supposes those spaces to be angles, not lines; believing that the eye is more affected by direction than by distance. The basis of his theory, accordingly, is, that bodies are agreeable to the eye, so far as symmetry is concerned, whenever the principal angles are exact submultiples of some common fundamental angle. According to this theory we should expect to find, that spaces in which the prominent lines are horizontal and vertical lines, will be agreeable to the eye when all the principal parallelograms fulfil the condition that the diagonals make with the sides, angles which are exact submultiples of one or of a few right angles. This application of the theory was exemplified by a sketch of the new Corn Exchange erected in the Grassmarket, Edinburgh, by David Cousin, Esq., whose beautiful design was shown to have been constructed with a special reference to the fulfilment of this condition.

The author was stated to proceed to apply his theory to the construction of the human figure, in which we should expect *à priori* to find the most perfect development of symmetric beauty. Diagrams were exhibited which represent, with remarkable accuracy, the human figure; and it was explained that not a single lineal measure is employed in their construction. The line which shall represent the height of the figure being once assumed, every other line is determined by means of angles alone. For the female figure, those angles are, one-half, one-third, one-fourth, one-fifth, one-sixth, one-seventh, and one-eighth of a right-angle, and no others. It must be evident, therefore, that, admitting the supposition that the eye appreciates and approves of the equal division of the space about a point, this figure is the most perfect which can be conceived. Every line makes with every other line a good angle. The male figure was stated to be constructed upon the female figure by altering most of the angles in the proportion of 9 : 8; the proportion which the ordinary untempered flat seventh bears to the tonic.

A drawing was exhibited, which had been designed with great care from the life, by the distinguished academician, John A. Houston, Esq. On this drawing the author had constructed his diagrams; and the coincidence of theory with fact was seen to be complete. Professor Kelland argued, that a principle so simple and comprehensive in its character, and thus far apparently truthful in the conclusions to which it leads, merits, and should receive, the most complete and rigid examination.

PLATE-IRON GIRDER BRIDGES.

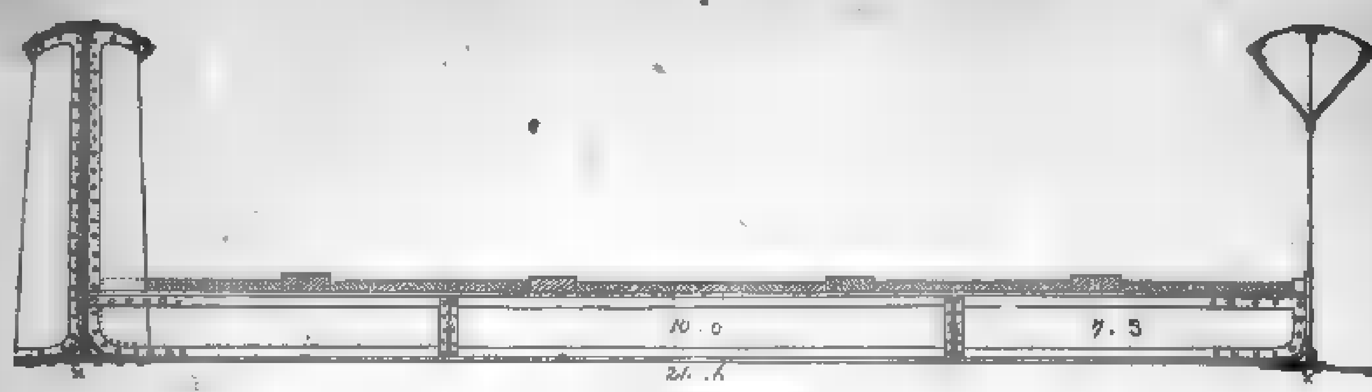
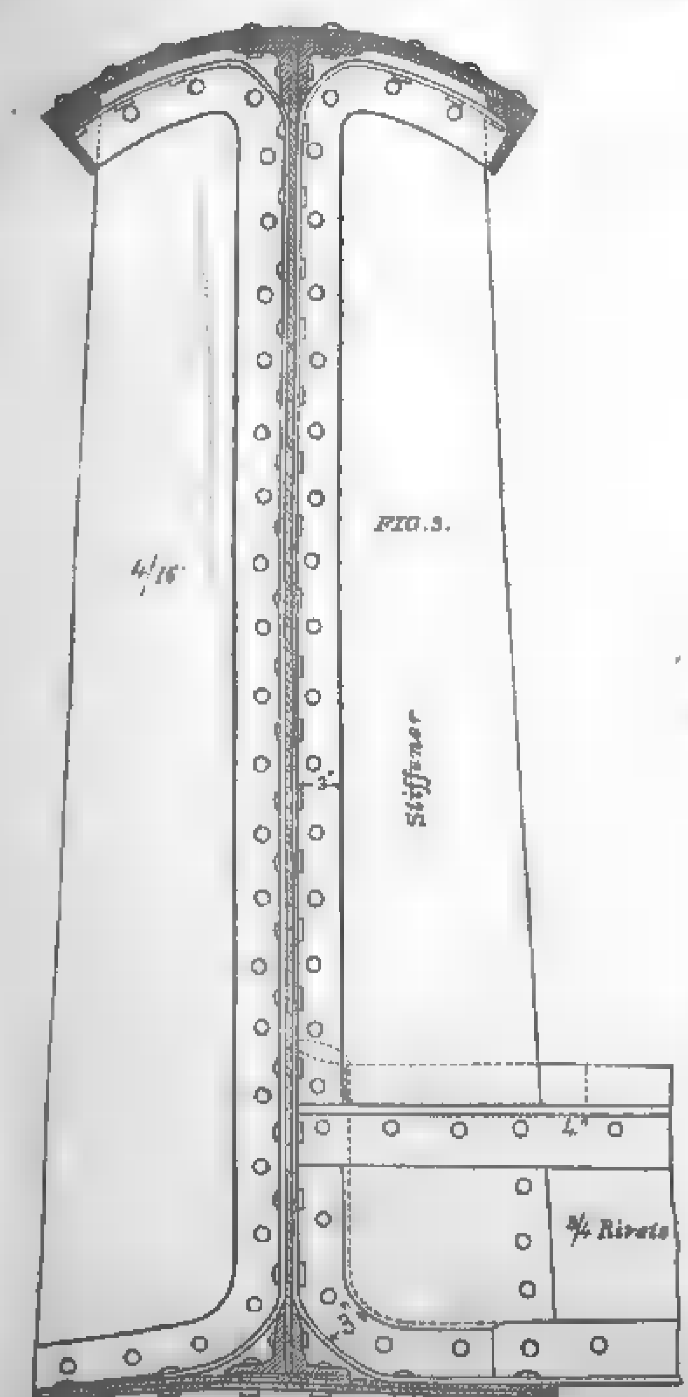
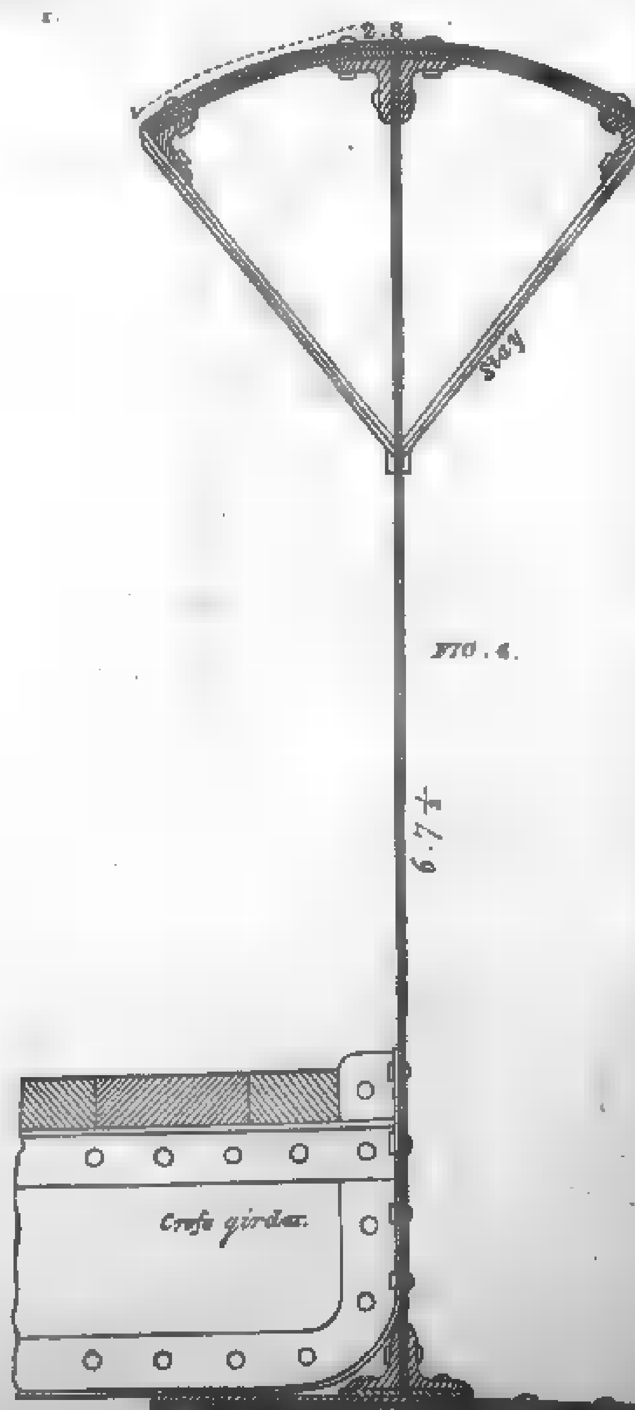


Fig. 1.—Transverse Section.



Enlarged Section of Girder, showing the Stiffeners.



Section through Girder, showing the Stays to Stiffen the Top Plate.

PLATE-IRON GIRDER BRIDGES.

The annexed engravings show the construction of one of the numerous bridges which have been designed by Mr. Martin, the engineer, to carry the railway from the London and North-Western Railway to the East and West India Docks. It carries the railway over Randolph-street, Camden Town.

The peculiarity consists in constructing the bridge with two side girders, each of a single web, of plates of iron, 71 feet long, 6 ft. 7½ inch high, and $\frac{7}{16}$-inch thick; put together with plates 5 inches wide, overlapping the vertical joints, and ¾-inch rivets placed 3 inches apart, and fixed to the top and bottom plates by angle-iron 3 inches wide, and ⅞-inch rivets. The bottom plate is 2 ft. 8 in. wide, made with $\frac{7}{16}$-inch plates in lengths of 8 feet each, with plates overlapping the joints 6 in wide. The outer flange is curved down 1 inch, to throw off the wet; the top plate is 2 ft. 8 in. girt, made with $\frac{7}{16}$-inch plates, excepting the three middle plates, which are ⅜-inch in thickness; the top is curved down 5 inches, and put together with inch rivets. The girders are stiffened by eight vertical plates on each side of the web, of $\frac{7}{16}$-inch iron, fixed by angle-iron 3 inches wide, and ¾-inch rivets placed 4 inches apart. There are also two similar stiffeners at each end, of ⅝-inch iron. The top plate is further stiffened by stays of T-iron, 6¼ inch wide between each pair of stiffeners.

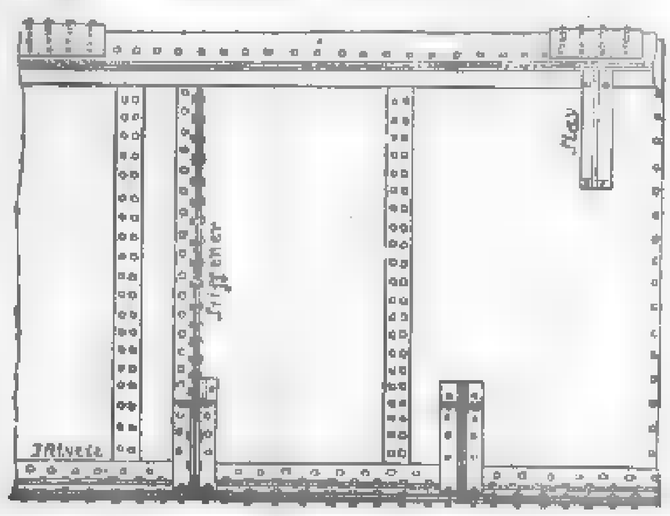


Fig. 2.—Side View of Longitudinal Girder.

The cross girders are 24 ft. 6 in. long and 1 ft. 4 in. high, made with ⅜-inch plates in three lengths, and stiffened by angle-iron top and bottom and on each side, 3½ inches wide, and fastened with ¾-inch rivets 4 inches apart. The ends of these cross girders rest upon the two girders first described.

Fig. 1 is a cross section of the bridge. Fig. 2 is a side view of part of one of the longitudinal girders. Fig. 3 is an enlarged section of one of the girders, showing the stiffeners. Fig. 4 is a section through the same girder, showing the stays to stiffen the top plate.

THE BRITANNIA BRIDGE.

The permanent public opening of the new line of tubes for the down line from London to Dublin took place on Monday 21st ult., the great structure being now in all important respects made complete. On the 19th Oct., Captain Simmons, the Government Inspector, went over it early in the morning, and instituted, in conjunction with the engineers, a long series of experiments.

The first experiment consisted in passing two locomotive engines through the tube, and resting them at intervals in the centre of the sections. At 9 o'clock a train of 28 wagons and two locomotives, with 280 tons of coal, was drawn into all four of the tubes, the deflections being carefully noted. These deflections were ascertained to be exactly three-fourths of an inch under this load. After repetitions of these experimental ordeals, which occupied several hours, the train of 280 tons, with its two locomotives, was taken out about a mile distant from the tube, and then suddenly shot through it with the greatest attainable rapidity, and the result was that the deflection at this immense velocity of load was sensibly less in the way of undulation than when the load was allowed to remain at rest on the tube. The contrivance by which the effects are indicated with great precision consists in a large pipe containing water, laid along the lower cells of the tube, one end rising up within the tube at the centre, and the other end fixed against the stonework of the abutments of the bridge. Both extremities of this pipe are furnished with glass tubes and graduated scales, by which the relative levels of the water were easily ascertained. As the slightest leakage or evaporation over the ordinary thermometric expansion of the water would derange the level, while only half the actual deflection of the tube was registered at each end of the pipe, these disadvantages are obviated by the addition of a large reservoir of water in the interior of the tube, which is covered with oil and placed beside the graduated scale.

Messrs. E. and L. Clark, the resident engineers, who have watched minutely from day to day all the developed peculiarities of the novel undertaking, state that the heaviest gales through the Straits do not produce so much motion over the extent of either tube as the pressure against the side of the tubes of 10 men; and that the pressure of 10 men keeping time with the vibrations produces an oscillation of 1¼ inch, the tube itself making 67 double vibrations per minute. The strongest gusts of wind that have swept up the Channel during the late stormy weather do not cause a vibration of more than a quarter of an inch. The broadside of a storm causes an oscillation of less than an inch; but when the two tubes are braced together by frames, which is now being done, these motions, it is expected, will cease. The action of the sun at midday does not move them more than a quarter or three-eighths of an inch. The daily expansion and contraction of the tube varies from half an inch to three inches, attaining either the maximum or minimum at about 3 o'clock a.m. and p.m. If a compass be held over any part of the bottom of the cells, the south pole is affected, and if held over the top of the cells, the north pole is affected; and this effect is observable in all parts of the tube, whether at the centre or the end, although their position is only about 10° west of the magnetic meridian. Preparations are making for covering the tubes with a light arched roof of peculiar construction.

GRAND CONTINENTAL CANAL.

A Belgian engineer, M. de Laveleye, proposes to connect the Seine and the Rhine by means of a canal. This was one of Charlemagne's ideas—equally with that connection of the Rhine and the Danube which has been effected in our own day by means of the Ludwig Canal. The points which M. de Laveleye proposes to connect—Sedan and Trier—are but ninety-five miles asunder, intersected by the rich and populous Grand Duchy of Luxembourg; and presuming the canal to be made, navigation would be open from London to the Black Sea and Constantinople, through the heart of the Continent, and by means of the great watercourses on or near whose banks lie the materials of nearly all the internal and external trade of Europe. Vessels would ascend the Seine from Havre to the junction of the Oise—they would turn up that river and continue to the Aisne—there they would again quit the main stream and proceed to the Ardennes Canal. At Donchery that canal falls into the Meuse, which is navigable already to Sedan. These rivers and canals are at present connected by tributaries and branches with the whole of north-eastern France, from Rouen to the wine-fields of Champagne, and also with the coal and metallic beds of Belgium. Less than a hundred miles of cutting—but through a district of which we suspect all the engineering difficulties are not fairly stated—will connect this immense net-work of navigation with another still larger and more important—of which the Rhine and the Danube are the main highways—Prussia, Germany, Austria, Hungary, and the Eastern provinces are the chief features—and the Black Sea and the Mediterranean are the great outlets. The Moselle already reaches the foot of the Ardennes. From it to the Meuse the distance is what we have stated. From Trier the navigation is open to Coblentz,—the Rhine would carry the vessels up to the Maine,—this river takes them past the trading emporium of Frankfort to the Ludwig Canal, and so into the Danube. On the face of such a project the advantages to France seem to be greater than to any other country—but the subject engages more attention in Vienna than in Paris. The estimated cost is 1,600,000*l.*,—a large sum; but the results are apparently of such magnitude as to insure the execution of the work at some period or other. The whole system of European internal navigation is incomplete so long as the eastern and western branches remain unconnected.—*Athenæum.*

METEOROLOGICAL QUARTERLY REPORT.

On the Meteorology of England and South of Scotland during the Quarter ending September 30, 1850. By JAMES GLAISHER, Esq., F.R.S., Hon. Sec. of the British Meteorological Society.

The mean daily temperature of the air was below its average value till July 13; the mean defect was 2·2°; from July 12 to the 24th the period was warm, and the average excess of temperature was 4·8°; from July 25 to August 3 the temperature was below the average; its mean deficiency was 1°; from August 4 to August 18, it was above the average; the mean excess was 2°; this was followed by a long period of fine, clear, dry, but cold weather; the average deficiency of temperature between August 19 and September 17 was 3·6°, and after September 18 the daily temperatures were slightly above their average values. Snow fell on Ben Lomond on August 23rd.

The several subjects of research in the past quarter are detailed below:

The mean temperature of the Air at Greenwich for the three months ending August, constituting the three summer months, was 61·1°, being 1·2° above the average of the 79 preceding summers.*

For the month of July was 62·2°, *exceeding* that of the average of the preceding 79 years by 0·9°, and of the preceding 9 years by 0·7°.

For the month of August was 60·2°, being 0·3° *less* than the average of the 79 preceding years, and 0·9° *less* than that of the preceding 9 years.

For the month of September was 56·4°, *exceeding* the average from the 79 preceding years by 0·1°, and *less* than that of the preceding 9 years by 0·7°.

The mean for the quarter was 59·6°, *exceeding* that of the average of the 79 preceding summer quarters by 0·2°, and *less* than that of the 9 preceding years by 0·3°.

The mean temperature of Evaporation at Greenwich for the month of July was 58·6°; for August was 56·6°; and for June was 52·9°. These values are 0·9° *greater*; 0·2° *greater*, and 1·6° *less* than those of the averages of the same months in the preceding 9 years.

The mean temperature of the Dew Point at Greenwich for the months of July, August, and September, were 55·8°, 53·1°, and 47·7° respectively. These values are 1·5° *greater*, 2·0° *less*, and 4·7° *less* respectively than the averages of the same months in the preceding 9 years.

The mean elastic force of Vapour at Greenwich for the quarter was 0·422 inch; being *less* than the average from the preceding 9 years by 0·008 inch.

The mean weight of Water in a cubic foot of Air for the quarter was 4·8 grains, being of the same value as the average from the preceding 9 years.

The mean degree of Humidity in July was 0·88, in August was 0·81, and in September was 0·75. The averages from the 9 preceding years were 0·79, 0·85, and 0·86 respectively.

The mean reading of the Barometer at Greenwich in July was 29·789 inches; in August was 29·787; and in September was 29·930. These readings are 0·010 *less*, of the *same value*, and 0·121 *greater* respectively, than the averages of the same months in the preceding 9 years.

The average weight of a cubic foot of Air in the quarter was 527 grains, exceeding that of the average of the preceding 9 years by 1 grain.

The Rain fallen at Greenwich in July was 2·9 inches, in August was 1·9 inch, and in September was 1·3 inch. The falls for these months, on an average of 9 years, are 2·3 inches, 2·6 inches, and 2·3 inches respectively.

The average daily ranges of the readings of the Thermometer in Air at the height of 4 feet above the soil, in July was 20·0°, in August was 18·6°, and in September was 17·1°. The averages for these months from the preceding 9 years were 19·4°, 17·6°, and 18·9° respectively.

The minimum readings of the Thermometer on Grass, with its bulb fully exposed to the sky, was at or below 40° on 8 nights; the lowest was 34°; and was above 40° on 23 nights; the highest reading was 55·5°. In August the readings were at and below 32° on 2 nights; the lowest reading was 28°; between 32° and 40° on 6 nights, and above 40° on 23 nights; the highest reading was 56°. In September the readings were at or below 32° on 9 nights, the lowest reading was 24°; between 32° and 40° on 6 nights, and above 40° on 15 nights, and the highest reading was 50°.

The daily horizontal movement of the Air at Greenwich in July was 79 miles, in August was 119 miles, and in September was 82 miles.†

The Temperature of the water of the Thames, from the observations of Lieut. Sanders, R.N., Superintendent of the *Dreadnought* hospital-ship, was 64·6° in July, 63·2° in August, and 57·9° in September.

Thunder Storms occurred on *July* 2 at Liverpool; on the 4th, at Uckfield and Nottingham; on the 9th at Uckfield; on the 15th at Oxford, Aylesbury, Hartwell-house and Rectory; Stone, Holkham, Norwich, and Oxford; on the 16th at Holkham, Hawarden, Liverpool, Manchester, Norwich, Nottingham, and Stonyhurst; on the 17th at Greenwich, Uckfield, Aylesbury, Hartwell, Stone, Linslade, Cardington, Leicester, Greenwich, Nottingham, and s.w. of Dunino; on the 18th at Helston, Exeter, Greenwich, St. John's Wood, Oxford, Aylesbury, Hartwell, Stone, Linslade, Cardington, Leicester, Durham, and Nottingham; on the 23rd at Jersey and Hawarden; at Exeter on the 25th; on the 28th at Guernsey and Helston; on *August* 3 at Rose-hill, Oxford; on the 5th at Holkham; on the 6th at Stone and Dunino; on the 7th at Hartwell; on the 8th at Oxford, Hartwell, Stone, Linslade, Cardington, Hawarden, Liverpool, York, and North Shields; on the 9th at York and Hartwell Rectory; on the 12th at Greenwich, Norwich, and Oxford; on the 13th and 15th at St. John's Wood; on the 19th at Liverpool; on the 20th at Holkham and Nottingham; the 21st at Nottingham; the 24th at Greenwich and Hartwell; the 27th at Guernsey; the 29th at Guernsey and Helston; and on the 30th at Guernsey; on *September* 20th at Exeter; on the 23rd at Holkham and Norwich; on the 24th at Holkham; on the 26th at Stonyhurst; and on the 30th at Jersey and Trowbridge.

At Uckfield, during the third week of July, the weather was wet, and several thunder storms visited many places in Sussex.

At Hartwell Rectory, on July 15th, at 1 h. 30 m., there was a storm, with thunder and lightning, and rain fell to the depth of 0·510 inch; the weather continued stormy with sheet lightning all the evening. On July 17th, at 6 h. 30 m. p.m., there was another thunder storm, but very little rain fell; and sheet lightning occurred at intervals during the evening, to the s. and w. On July 18th, at 3 h. 30 m. p.m., there was a thunder storm, followed by sheet lightning all the evening, with heavy rain falling, amounting next morning to 1·610 inch.

At York, on August 8th, between the hours of 6 and 8 in the evening, there was a thunder storm. The Diocesan School and the Roman Catholic Chapel were struck by lightning, and injured. Sheep were killed, and two individuals were knocked down, but no human life was lost. This was the most severe storm which has visited York for the last 20 years.

At Stonyhurst, on July 16th, the lightning was the most brilliant Mr. Weld ever remembers to have witnessed. The thunder resembled the explosion of fireworks, and on several occasions lightning darted from the same centre in three or four directions: the sky seemed traversed in every direction by streaming lightning of the most vivid description. The thunder was incessant, but very distant, and no rain fell. Mr. Weld heard of seven persons being killed, and about as many more struck, and several valuable cows and horses were destroyed.

Thunder was heard, but Lightning was not seen, on *July* 4 at Guernsey; on the 16th at St. John's Wood, Linslade, Stone, and Wakefield; on the 17th at Greenwich, Durham, and North Shields; on the 18th at Wakefield; on the 19th at Stone; and on the 23rd at Guernsey; on *August* 6th at Oxford, Aylesbury, Holkham, and North Shields; on the 12th at Uckfield, Linslade, Holkham, Hawarden, and Liverpool; on the 14th at Jersey; on the 19th at Norwich; on the 21st at Dunino; on the 23rd at Cardington; on the 24th at Exeter, Oxford, Hartwell Rectory, and Stone; and on the 28th at Nottingham; on *September* 3rd and 24th at Aylesbury; on the 26th at Durham and North Shields; and on the 27th at St. John's Wood.

Lightning was seen, but Thunder was not heard on *July* 8th at Uckfield; on the 15th at Uckfield, Hartwell Rectory, Stone, and Stonyhurst; on the 16th at Leicester, Nottingham, and Manchester; on the 17th at St. John's Wood, Oxford, Hartwell Rectory, and Liverpool; on the 19th at Stone; and on the 29th at Manchester; on *August* 5th at Cardington and Stone; on the 6th at Highfield House; on the 8th at Stonyhurst; on the 9th at Cardington; on the 10th at North Shields; on the 22nd at Norwich and North Shields; on *September* 23rd at Uckfield, Greenwich, Linslade, and Cardington; on the 24th at Greenwich, Oxford, and Stone; on the 29th at Hartwell Rectory; and on the 30th at Helston, Uckfield, Greenwich, St. John's Wood, Oxford, Hartwell Rectory, and Linslade.

Aurora Boreales were seen at Norwich on July 5th; on the 19th at Norwich; on August 6th at Stone; on the 21st at Stone and Dunino; on September 6th and 10th at Nottingham; on the 13th at Nottingham and Hawarden; on the 14th at Stone; and on the 28th at Hartwell House, Hartwell Rectory, and Stone.

Hail fell on July 12th at Hawarden; on the 20th at Oxford and Liverpool; and at Dunino on the 21st and 22nd; on September 29th at Guernsey; and on the 30th at Jersey.

Snow fell on Ben Lomond on August 23rd.

Meteors.

At Uckfield meteors were very numerous during the nights of July 12, 16, 30; and August 9; September 10, 11, and 12.

At Hartwell Rectory, on August 11, a large meteor was seen at 10h. 10m. p.m.

At Stone, on July 13, at 11h. 20m. p.m., a meteor passed from Arcturus to Peterson's comet.

On July 29, at 9h. 57m. p.m., a meteor crossed Corona Borealis from N. to S.

September 6, at 11h., a meteor passed from Pisces to Fomalhaut.

September 17, at 10h. 4m. p.m., a meteor passed from α Corona Borealis to 4° above Saturn.

September 28, at 9h. 30m., a meteor as bright as Capella shot from α Draconis to γ Ursæ Majoris.

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* See my paper in the *Philosophical Transactions*, part ii, 1850, upon the temperature &c., of the years from 1771 to 1849; and also see the *Illustrated London Almanack* for 1851, for some particulars of all those years.

† See the *Philosophical Magazine* for November for Wind Tables, &c.

At Stonyhurst, five meteors were seen on August 14, 23, 28, and 29.

At Highfield House, near Nottingham, on July 4, at 9h. 26m. p.m., a meteor, which increased in brilliancy and size as it progressed, until, from a mere point, it attained a size equal to three times the apparent diameter of Jupiter, and nearly six times the brightness of that planet; its colour was pale blue, and it fell nearly perpendicular downwards, inclining very slightly towards the E.; it passed from halfway between λ and ρ Antinous, fading away 2° to the east of α Capricorni, and on the same level with that star. Its motion was slow, duration 2s.; at first was unaccompanied by sparks; finally it suddenly separated, and almost instantly vanished.

On July 9th, at 10h. p.m., a meteor was seen of twice the size of Jupiter, and similar in colour; it fell downwards from Coma Berenices.

On August 1, at 10 p.m., a small meteor, with a train of light, fell downwards from α Aquilæ.

On August 3, at 10h. 55m. p.m., a meteor, equal in size to a star of the fifth magnitude, fell rapidly from α Coronæ Borealis to ξ Bootes; its duration was 0·5s, and it became extinct instantly.

On August 6, at 10h. p.m., three small meteors were seen; another meteor was seen at 10h. 22m. p.m., which fell from ϵ Pegasi to β Aquarii, leaving a train of light for 20s. afterwards.

On August 6, at 10h. 20m. p.m., a meteor was seen by A. S. H. Lowe, Esq., which fell from ι Ursæ Majoris; at 11h. 15m. p.m., a meteor fell from α Ophiuchi.

On August 9, at 11h. 15m. p.m., two meteors were seen, one being in the zenith.

On August 12, at 10h. 32m. p.m., E. J. Lowe, Esq., saw a meteor, which moved horizontally, and increased in brilliancy from being equal to a star of the fifth to one of the second magnitude; its colour was blue, and duration 0·2s.; its path was from 24 Camelopardalis towards λ Draconis.

On August 12, at 10h. 33m., a meteor passed from τ Cassiopeiæ towards θ Ursæ Majoris, and was equal in size to a star of the third magnitude; its colour was blue, and its duration 0·5s.

On the same night, at 11h. 9m., a meteor fell from between β, γ, and λ Pegasi perpendicularly down to within 20° of the horizon, when it went behind a cloud, and from one to two seconds after, a flash, resembling lightning, and quite as vivid, proceeded from behind the cloud, followed immediately by a second flash; the meteor itself was about 12′ in diameter, was globular in form, and yellow in colour; it moved very slowly; this meteor was followed by a train of light.

On August 14, at 9h. 45m. p.m., a meteor was seen four or five times larger than Jupiter; it was a pale straw colour, very globular in form, with a red-defined disc, no train of light visible; it fell between λ Bootes and η Ursæ Majoris perpendicularly downwards; it passed 3° or 4° north of the large group of stars in Coma Berenices; its duration was 2s.

On August 14, at 9h. 48m. p.m., a small meteor moved from 24 Camelopardalis to Ursæ Majoris; its colour was blue, and duration 0·5s.

On the same night, at 9h. 49m. p.m., a meteor fell perpendicularly down from α Cassiopeiæ; it was about the size of a star of the third magnitude, and of a blue colour.

On August 22, at 10h. p.m., a meteor fell from ι Cephei through λ Andromedæ.

On August 22, at 10h. 24m. p.m., a meteor was seen about the size of Arcturus, and of a yellow colour; it fell perpendicularly down, inclining to the north from 5° below γ Bootes.

On August 29, at 9h. 59m. 35s., a meteor of the size of a star of the third magnitude was seen; it was blue in colour, and moved very rapidly; it passed from η Bootes to Arcturus; its duration was 0·5s.

On August 29, at 10h. 1m. p.m., a meteor of the size of a star of the second magnitude was seen; its colour was red; it left a train of red sparks, and moved rapidly from γ Trianguli to Saturn.

On August 29th, at 10h. 4m. p.m., a meteor was seen of an orange scarlet colour; it moved slowly from ϵ Persei to near 21 Pegasi in a horizontal direction; its duration was 2s.; when first seen it was equal to a star of the fifth magnitude, but gradually increased in diameter as it progressed, until it became three times as large as Saturn; there was no large ball of light; it disappeared suddenly.

On the same night, at 10h. 7m. p.m., a meteor was seen, which moved rather slowly; was of a blue colour, with a slight tail; duration 1s.; in size superior to a star of the second magnitude.

On September 1, at 9h. 5m., a meteor was seen in the zenith.

On September 2, at 11h. 13m., a meteor was seen passing rapidly from δ Equulii.

On the same night, at 11h. 16m., a similar one from ϵ Aquarii to β Capricorni.

On the same night, at 11h. 19m., a meteor passed from Aldebaran to β Ophiuchi.

Again, on the same night, at 10h. 20m., from η Ursæ Minoris to ϵ Ursæ Majoris; duration 1s.; colour yellow.

On September 26, at 10h. 45m., p.m., a meteor which moved from S.S.E. to S.W., at an elevation of 45°, leaving a long train of light behind, was seen.

Frost.—The first frost was seen on August 22nd, at Uckfield, when wheat and barley sheaves were frozen into a stiff mat; and Mr. Prince saw ice as thick as a wafer upon his cucumber frames. On September 5th there was a sharp frost at Hartwell House; and at Trowbridge, September 7th and 9th.

Solar halos were seen on July 6th at Uckfield; on the 10th near Oxford and Nottingham. On August 3rd at Dunino; on the 7th at Greenwich; on the 20th at Dunino; on the 28th at Uckfield; and on the 29th at Exeter and Nottingham. On September 12th at Guernsey; and on the 24th at Dunino.

Lunar halos were seen on July 22nd at Stone, Nottingham, and Norwich. On August 21st at Uckfield and Nottingham; on the 22nd at Uckfield, Oxford, Cardington, and Nottingham; on the 23rd at Uckfield and Nottingham; on the 24th at Hawarden; on the 26th at Stonyhurst; and on the 31st at Durham. On September 18th at Jersey, Guernsey, Oxford, and Hawarden; on the 21st at Oxford, Hartwell Rectory, Cardington, Stone, and Durham; on the 22nd at Oxford, Hartwell Rectory, Cardington, Norwich, and Stone; on the 24th at Oxford; on the 25th at Cardington; and on the 26th at Durham.

Lunar Coronæ were seen at Hartwell Rectory on August 14th and 16th.

Lunar Rainbows were seen on August 30th at Exeter; on August 22nd, at 10 h. 40 m. p.m., at Battersea Bridge, London, as seen by the Rev. Charles Lowndes.

Fog, on July 11th at Stone; on the 12th at Stone and Hartwell. On September 11th at Greenwich; on the 12th at Stone, Hartwell House, and Trowbridge; on the 14th at Stone, Hartwell, and Trowbridge; on the 15th at Hartwell and Trowbridge; on the 18th at Trowbridge; on the 19th at Hartwell and Trowbridge; on the 24th at Stone and Hartwell; and on the 25th at Stone, Hartwell Rectory, and Greenwich.

Remarkable Rain.

At Guernsey, on August 8th, rain to the depth of 1·333 inch fell in 16 hours; and on September 28th upwards of one inch of rain fell within 12 hours.

At Falmouth, on September 24th, rain to the depth of 1·93 inch fell, of which 0·8 inch fell in little more than half an hour.

At Exeter, from August 25th to September 19th, no rain fell, and the weather was clear, warm, and fine, for several days—the sky was cloudless: the average reading of the barometer was about 30·25 inches.

* The amount of rain which fell during the thunder storm on September 20th was 1·95 inch, which is the amount by which the rain in the month exceeded the average, the former being 4·33 inches, and the latter 2·39 inches, or rather more than one-half.

At Uckfield, on July 17th, the depth of rain which fell within an hour was 1·81 inch, which is an almost unprecedented amount to have fallen in so short a time in the south of England. Much heavy rain fell during the last week of September, which was very beneficial to the autumn crops.

At Southampton no rain fell till the 21st of September, and on September 27th it fell to the depth of 1·13 inch.

At Aylesbury, on July 15th, rain to the depth of 0·75 inch fell in 42 minutes. No rain fell from the 27th of August to the 20th September, and much inconvenience is still felt from the short supply of water.

At Derby, the amount of rain which has fallen in the nine months of this year is 15·6 inches; the average is 22·4 inches.

At Norwich, on July 26th, rain fell to the depth of 1·18 inch.

At Holkham, on July 16th, rain fell to the depth of 1·29 inch in 8½ hours.

At York, on August 8th, rain to the depth of 0·74 inch fell within two hours. No appreciable quantity of rain fell in York between the 28th of August and the 20th of September.

At Stonyhurst, on August 5th, rain fell to the depth of 0·784 inch; and on August 7th to the depth of 0·858 inch.

At North Shields, on July 25th and 26th, rain fell to the depth of 1·482 inch. The month of September was remarkably fine and dry till the 20th; on that day there was a heavy fall of rain, amounting to 0·76 inch in five or six hours.

The following observations of natural phenomena were taken at Highfield House, near Nottingham (being nearly the centre of England) by E. J. Lowe, Esq., F.R.A.S.

July 1. Tulip tree in full flower.
.. 4. Cherries ripe.
.. 7. Enothera macrocarpa just in flower; black currants ripe; red currants scarcely ripe; white currants scarcely ripe
.. 17. Lime tree in full flower; strawberries, excepting the late varieties (as Cox's scarlet, British Queen), going over; raspberries, many ripe
.. 20. Field of turnip seed cut; field of pease cut
.. 28 Strawberries nearly over; picotees in full flower; carnations just in flower; hollyhocks coming into flower
Aug. 1. Field of wheat sheared at Lenton
.. 6. Oats cut at Beeston
.. 7. Oats cut near Nottingham; wheat cut at Beeston
Aug. 11. Apricots ripe
.. 12. Pears (Green Chisel) ripe; apples (Joaneton) ripe
.. 13. Some oats led away; some wheat led away
.. 21. Gooseberries over; currants over
.. 23. Frost injured half-hardy plants
.. 26. Mountain ash berries quite ripe; corn nearly all harvested
Sept. 1. Blackberries ripe
.. 5. Peaches ripe; apple (Keswick) nearly ripe; wall plums nearly ripe
6 and 7. Few wasps about; they are very scarce this year
.. 17. Nectarines ripe; plums (Victoria) ripe; (Emperor) ripe; dahlias in full glory of bloom; autumn roses in bloom
.. 19. plums (damson) ripe

The following table contains the mean quarterly values of the several subjects of investigation.*

* See the Quarterly Report of the Registrar-General for the monthly values at all the stations.

Quarterly Meteorological Table for the Quarter ending September 30th, 1850.

The observations have been reduced to mean values, and the hygrometrical results have been deduced from "Glaisher's Tables."

Names of the Places.	Mean Pressure of Dry Air reduced to the level of the Sea.	Mean Temperature of the Air.	Highest reading of the Thermometer.	Lowest reading of the Thermometer.	Mean Daily Range of Temperature.	Mean Monthly Range of Temperature.	Range of Temperature in the Quarter.	Mean Temperature of the Dew-Point.	Wind. Mean Estimated Strength.	Wind. General Direction.	Mean Amount of Cloud.	Rain. Number of Days on which it fell.	Rain. Amount Collected.	Mean weight of Vapour in a cubic foot of Air.	Mean additional weight of water required to saturate a cubic foot of Air.	Mean degree of Humidity.	Mean whole amount of Water in a Vertical Column of Atmosphere.	Mean Weight of a cubic foot of Air.	Height of Cistern of Barometer above the Level of the Sea.	Names of the Observers.
	in.	°	°	°	°	°	°	°					in.	gr.	gr.		in.	grs.	ft.	
Jersey	29·652	60·2	81·0	48·0	14·4	30·7	33·0	54·5	1·7	S.W.&N.W.	4·8	36	6·4	4·9	1·6	0·822	6·0	529	84	Rev. Samuel King, F.R.A.S.
Guernsey	29·599	60·1	75·5	51·5	10·9	19·2	24·0	56·2	1·7	W. & E.	4·9	35	8·8	5·2	0·6	0·899	6·4	529	123	Dr. Hoskins, F.R.S.
Helston	29·614	58·7	80·0	40·0	13·3	33·3	40·0	54·6	1·4	S.W.&N.W.	5·8	37	7·9	4·9	0·9	0·850	6·0	528	106	M. P. Moyle, esq.
Falmouth	..	59·1	78·0	40·0	16·5	33·3	38·0	..	1·4	N.	6·6	33	10·6	..	..	..	..	..	120	L. Squire, esq.
Truro	29·694	59·5	77·0	38·0	14·8	34·3	38·0	53·7	1·0	N.	5·9	41	4·6	4·8	1·0	0·884	5·9	530	55	Dr. Barham.
Torquay	..	60·5	77·0	47·0	12·2	24·3	30·0	53·8	2·3	N.	..	29	8·0	4·7	1·3	0·780	5·7	..	100	Edward Vivian, esq.
Exeter	29·600	59·2	81·4	40·7	15·8	30·7	40·3	53·1	1·7	W.	5·7	30	8·0	4·7	1·2	0·804	5·9	529	140	Dr. Shapter.
Uckfield	29·580	59·5	89·0	34·0	22·3	45·3	55·0	51·8	..	W.	..	45	7·4	4·8	1·5	0·747	5·8	528	160	C. L. Prince, esq.
Southampton	29·569	59·7	81·0	36·0	17·0	35·9	45·0	..	0·8	..	6·1	38	3·1	..	..	..	6·5	..	55	John Drew, esq., F.R.A.S.
Greenwich Royal Observatory	29·609	60·0	87·0	39·0	16·6	38·0	48·0	52·2	..	N.E. & S.W.	..	39	6·1	4·8	1·2	0·788	5·6	527	159	The Astronomer Royal
Maidenstone Hill, Greenwich	29·608	56·5	84·8	39·8	14·6	30·9	44·7	54·8	..	N.E. & S.W.	5·6	35	5·7	5·0	0·7	0·872	6·1	529	107	Mr. William Ellis
St. John's Wood	29·649	57·5	83·0	38·0	16·0	37·0	45·0	49·6	..	..	..	48	5·8	4·1	1·2	0·779	5·1	530	150	George Leach, esq.
Chiswell-street, London	..	61·2	80·0	46·0	11·4	27·3	34·0	51·5	..	..	..	37	5·9	4·5	1·8	0·710	6·5	527	..	David Slate, esq.
Aylesbury	29·630	58·2	86·0	32·0	24·2	46·4	54·0	51·1	0·7	S.	6·6	37	7·5	4·4	1·4	0·765	5·4	525	264	Thomas Dell, esq.
Stone Observatory	29·600	57·8	85·5	33·0	19·9	42·0	52·5	50·7	..	S.W.	5·6	46	5·6	4·3	1·2	0·784	4·4	523	310	Rev. J. B. Reade, F.R.S.
Hartwell (near Aylesbury)	29·590	58·6	86·0	32·0	23·4	46·0	56·0	52·6	0·9	N.N.W.	..	52	6·1	4·6	1·0	0·817	5·3	526	260	Dr. Lee, F.R.S.
Hartwell Rectory	29·602	57·1	81·5	33·5	17·2	39·6	45·0	50·6	0·6	N.W.&S.W.	5·8	39	6·9	4·2	1·3	0·771	5·1	526	290	Rev. C. Lowndes, F.R.A.S.
Linslade (Bucks)	..	57·2	88·5	35·0	19·3	49·5	60·5	..	..	S.W.	..	45	7·0	..	..	..	..	..	313	John Osborn, esq., Junr.
Radcliffe Observatory, Oxford	29·638	57·2	79·0	35·1	15·9	35·5	44·5	51·5	1·6	N.E. & S.W.	7·2	38	8·0	4·5	1·0	0·813	5·5	526	210	M. J. Johnson, esq., F.R.A.S.
Rose Hill (near Oxford)	..	..	84·5	36·5	..	35·9	48·0	..	..	..	..	36	7·8	..	..	..	..	..	270	Rev. J. Slatter, F.R.A.S.
Cardington (near Bedford)	29·604	58·0	83·5	35·0	19·6	40·0	48·5	52·4	0·9	Var.	7·1	39	6·6	4·6	1·1	0·806	5·7	529	100	S. C. Whitbread, esq., F.R.A.S.
Norwich	29·536	57·8	81·0	41·0	16·8	34·0	40·0	52·8	..	S.W.&N.W.	6·6	43	10·2	4·7	0·9	0·848	5·7	530	23	C. Brooke, esq., F.R.A.S.
Leicester Museum	29·539	58·8	79·0	38·0	14·4	32·6	41·0	50·0	1·8	W.	7·5	31	6·1	4·3	1·1	0·791	5·2	527	175	John Stallard, esq.
Holkham	29·610	57·1	80·8	37·5	14·6	30·6	43·3	51·8	1·1	N.W.	6·4	47	9·2	4·4	1·0	0·821	5·4	531	69	The Earl of Leicester.
Highfield House, Notts	29·557	57·2	87·3	33·0	21·6	45·2	54·3	53·1	0·4	Var.	6·6	47	7·1	4·7	0·7	0·865	5·8	529	163	E. J. Lowe, esq., F.R.A.S.
Derby	29·585	56·5	82·0	..	..	..	..	52·6	..	S.E.	..	43	6·9	4·7	0·8	0·856	5·7	530	..	John Davis, esq.
Hawarden	29·642	56·5	81·5	39·5	12·7	26·0	42·0	48·8	1·7	N.W.	7·0	44	7·7	4·1	1·3	0·768	5·0	528	260	Dr. Moffatt, F.R.A.S.
Liverpool	29·593	58·1	80·0	40·3	10·2	24·9	34·8	53·0	1·3	N.W.	7·6	43	7·8	4·7	0·9	0·837	5·7	530	87	John Hartnup, esq., F.R.A.S.
Wakefield	29·585	56·6	83·0	31·0	21·4	44·2	52·0	52·2	2·0	W.	6·7	48	6·7	..	..	..	..	..	115	W. R. Milner, esq.
Stonyhurst	29·679	54·0	77·0	35·2	..	..	42·4	50·0	1·3	E. to W.	6·8	49	12·2	4·3	0·8	0·818	5·2	527	381	Rev. A. Weld, F.R.A.S.
York	29·612	55·7	78·0	35·0	14·5	36·0	43·0	50·9	..	Var.	..	38	6·4	4·3	0·9	0·833	5·3	530	50	John Ford, esq.
Whitehaven	29·547	56·4	84·0	39·5	12·8	31·2	44·5	53·0	3·1	N.W.	..	45	12·6	4·6	0·6	0·880	5·5	532	80	J. F. Miller, esq., F.R.S.
Durham	29·596	53·9	76·8	34·8	14·8	34·3	42·0	49·4	0·6	S. & W.	6·3	44	6·3	4·2	0·8	0·828	5·1	529	340	R. C. Carrington, esq.
Newcastle	..	55·5	76·0	37·0	14·8	35·0	39·0	51·0	..	S.W. & E.	..	50	..	4·5	0·7	0·870	5·5	532	..	George Morris, esq.
North Shields	29·608	53·5	70·4	36·8	11·1	30·0	33·6	50·2	2·8	N.E. & S.W.	3·4	50	6·6	4·4	0·4	0·827	5·3	535	124	Robert Spence, esq.
Glasgow	29·656	55·8	79·9	39·0	14·7	33·2	40·0	49·8	..	..	..	..	7·9	4·2	1·0	0·810	5·2	530	131	Dr. R. D. Thomson.
Dunino	..	56·3	81·0	37·0	20·0	39·0	44·0	49·1	1·9	Var.	3·8	31	6·2	4·4	1·2	0·792	5·0	..	250	David Tennant, esq.

The mean of the numbers in the first column is 29·605 inches, and it represents that portion of the reading of the barometer due to the pressure of air; the remaining portion, or that due to the pressure of water, is 0·397 inch: the sum of those two numbers is 30·002 inches, and it represents the mean reading of the barometer at the level of the sea for the quarter ending September 30, 1850.

Quarterly Meteorological Table, for different Parallels of Latitude.

Parallels of Latitude, &c.	Mean Temperature of the Air.	Mean of Highest Readings of the Thermometer.	Mean of Lowest Readings of the Thermometer.	Average Daily Range of Temperature.	Average Monthly Range of Temperature.	Average Quarterly Range of Temperature.	Mean Temperature of the Dew-Point.	Mean amount of Cloud.	Rain. Average Number of Days.	Rain. Average Fall.	Mean Weight of Vapour in a cubic foot of Air.	Mean Additional Weight required to saturate a cubic foot of Air.	Mean degree of Humidity.	Mean whole amount of Water in a vertical Column of Atmosphere.	Mean Weight of a cubic foot of Air.	Mean Height above the Sea.
	°	°	°	°	°	°	°			in.	gr.	gr.		in.	gr.	ft.
Guernsey and Jersey	60·1	78·3	49·8	11·7	25·0	28·5	55·4	4·9	81	7·6	5·1	1·0	·860	6·2	529	104
In the Counties of Cornwall and Devonshire	59·2	78·7	41·8	15·2	32·5	39·0	50·5	5·6	34	7·6	4·8	1·1	·814	5·9	528	116
South of Latitude 52°	58·4	84·4	35·8	19·0	39·9	49·0	51·5	6·2	38	6·9	4·5	1·2	·793	5·6	527	289
Between the Latitudes of 52° and 53°	57·8	82·3	36·9	17·5	36·7	45·0	52·	6·9	42	7·7	4·6	0·9	·829	5·6	529	88
Between the Latitudes of 53° and 54°	55·7	80·0	35·9	16·2	36·1	48·7	50·5	6·8	45	8·3	4·3	1·0	·811	5·2	529	202
Liverpool and Whitehaven	57·3	82·5	42·9	11·5	29·0	39·6	53·3	7·6	43	10·2	4·4	0·8	·859	5·6	530	88
Durham, Newcastle, & North Shields	54·8	74·4	36·2	13·6	32·4	38·2	50·4	4·9	41	6·5	4·4	0·6	·875	5·3	532	232
Glasgow and Dunino	56·1	80·5	38·0	17·4	36·1	42·4	49·4	3·8	31	7·1	4·3	1·1	·801	5·1	530	186

The highest reading of the thermometer in air was 89° at Uckfield, 88·5° at Linslade, and 86° at Hartwell; and the lowest readings were 31° at Wakefield, and 32° at Aylesbury and Hartwell. The extreme range of temperature, therefore, in England, during the quarter, was about 66°.

The least daily range of temperature took place at Guernsey, Liverpool, and North Shields; the mean value was 10·1°; and the greatest occurred at Uckfield, Aylesbury, and Hartwell, and the mean value was 23·3°.

The least monthly range of temperature occurred at Guernsey, Liverpool, and Torquay, and their mean value was 23·4°. The greatest monthly ranges occurred in the vale of Aylesbury and at Uckfield, and was 45·9°.

The average range of temperature in the quarter, at Uckfield, Hartwell, and Highfield House, was 55°; and at Guernsey, Jersey, and North Shields, was 30·9°.

Rain fell, on the least number of days, at Jersey and Torquay; and on the greatest number of days, at Wakefield, Stonyhurst, and North Shields. The places where the least falls took place are London and Truro; and the mean amount at those places was 5·3 inches. The largest falls occurred at Whitehaven and Falmouth, and their average was 11·6 inches.

Agricultural Reports.

Wheat began to be gathered in Jersey on July 15th, and on July 29th cutting of oats; at Hawarden, Guernsey, and Exeter on July 30th; on August 1st at Nottingham; on the 2d at Linslade and Cardington; on the 3rd at Leicester; on the 5th at Aylesbury; on the 8th at Oxford; on the 9th at Holkham; on the 12th at Odiham; on the 19th at Stonyhurst and North Shields; and on the 26th at Dunino.

Harvest finished, on August 30th at Guernsey; on the 31st at Cardington; on September 5th at Holkham; and on the 21st at Hawarden.

Uckfield.—August was very showery throughout, and the weather very unfavourable for securing the harvest. The mean temperature was below the average, and there was a remarkable absence of sunshine; an unusually low temperature occurred on the morning of the 22nd, the minimum being 34°, and on the grass 32°; in some situations it fell to 30°. The sheaves of wheat were *frozen* quite stiffly together, and ice was observed on good radiating surfaces. August 21st had been a very wet day, and rain fell to the depth of 0·77 inch, and the atmosphere became suddenly clear, and cold after sunset.—September was very fine and dry to the 20th day: this fine weather was much wanted for completion of harvest and the commencement of hop-picking in this locality. The barometer was very high during this period, and the wind veered only from N. W. to E.—The potatoe disease appeared in this neighbourhood on July 14th, and during the succeeding fortnight spread with great rapidity. Although the haulm was for the most part destroyed, yet the tubers were not so much diseased as they were in the summers of 1845 and 1846; and had July been a dry month, the probability is, that the disease would scarcely have been observed.

Hartwell Rectory.—The harvest has been gathered in a much shorter time than usual, the weather having been very favourable. The crop of peas and beans was very much blighted through the whole district; and in some few instances were not considered sufficiently good to cut and gather. The produce of the crops of wheat, barley, and oats does not come up to the average. The potatoe crop has turned out much better than was expected, there being very little disease.

Rose Hill, Oxford.—"The early potatoes were taken up by the 12th of July, with only one root bad out of a large quantity. This was a root of which the leaves were much cut by the frost in May; the main crop, however, continued flourishing till August the 3rd. After the thunder storm on that day they drooped their heads, and on the 5th were quite prostrate, and the disease was very prevalent in this neighbourhood. When the stalks decayed, a minute fungus appeared beneath the epidermis. It seems plain that the disease first causes the destruction of the leaves; and then the roots, if not near maturity, become surcharged with moisture and perish. My belief is, that the mode of culture is the secret; and potatoes whose roots were beneath the affection of sudden atmospheric changes, were safe."—Rev. J. Slatter.

Highfield House, near Nottingham.—On the whole the crop has been a poor one. Wheat not an average, and both quality and yield inferior. Barley not an average; oats not an average, yet better than wheat or barley. Turnips much destroyed by fly in the dry weather. Potatoes a fair crop, and not so much diseased as in former years. Beans sadly deficient. Hay crop was very light; and hay is now selling at from 4*l*. to 4*l*. 10*s*. per ton. Apples a very poor crop, most having been blown off by heavy gales. Pears deficient. Plums deficient. Peaches and nectarines a very poor crop. Apricots below an average. Strawberries below an average. Raspberries and gooseberries very good crop. Currants a good crop. Wasps have been rare this year. Mushr. oms a poor crop owing to the dry weather at Midsummer. The trees have not made their second growth.

North Shields.—The harvest was almost all gathered in during the early part of the month, but the crops had suffered very much from the effects of wind, on the 18th, 19th, 25th, and 26th of August.

Stonyhurst.—There was an average crop of hay this season, and it was for the most part well got in.—Wheat has succeeded well; the grain was well saved, and it was all housed by September the 2nd.—The season has been very unfavourable for oats; in many instances the early shoots were blighted, and those which succeeded them never came properly to maturity.—Though the crop is generally housed, there are still many fields out, and, in some instances, they are now reaping grain, which is still very far from being ripe.—Signs of disease appeared in potatoes about July 17, but in the roots only, the tops not being affected. About August 19 the tops were very generally blighted. About September 20 it was observed in many fields which had been newly ploughed this season, that about one-third of the crop was diseased, though in some places only one-sixth part was affected. The extent of the disease was found to vary very much even in the same field.—In fresh ploughed peat-land situated very high the crop was healthy, and almost cut, only about one-ninth part being diseased.—The turnip crop received a severe check at the early part of the season. The same is the case with regard to mangel-wurzel, which promises only an indifferent crop.—Beans have succeeded remarkably well this year.—During the summer pleuro-pneumonia has been frequent amongst the cattle.

CURVE OF GOTHIC ARCHITECTURE.

"*On the Curve of Gothic Architecture.*" By Mr. Laker. (Paper read before the Liverpool Architectural and Archæological Society, October 16th, C. Barber, Esq., V.P., in the Chair.)

After introducing his subject, Mr. Laker vindicated the terms Gothic and English, as applied to this style of architecture, on account of our Teutonic descent, and the great examples of the style being found in England. He claimed the distinction of Poetry for the Greek and Gothic styles, which was wanting in the Roman styles. Both the Greek and the Gothic were constructed upon curved lines—the Greek upon conic sections, and the Gothic upon similarly modified curves. The Roman was constructed upon circular curves only, and the Poetry was lost. One great writer upon architecture had said, that in coming out of a Gothic cathedral, and entering St. Paul's, "I have left the regions of Poetry, and have come into the regions of common-sense—Prose." (He might have expressed himself with equal accuracy had he said he had left the region of *Architecture*, and come into the region of common-sense—*Building*.) With regard to the Gothic curve when applied to groining, it had been elliptic, or struck from four centres, from the period of its introduction: but for obtaining these centres we had nothing to guide us. Mr. Willis, and all the late writers on Architecture, had admitted this; and Weale's lately published Atlas had exhibited the subterfuges resorted to, to obtain a correspondence between the long and short ribs. The fundamental rule, that the curves should spring from the line of the impost, was abandoned; one centre was to be taken a little above this line, another a little below it; and one was actually to be stilted so much, as to spring about midway between the impost and the roof. He (Mr. Laker) proposed to furnish a principle which would give the centres of all these curves with perfect certainty and perfect harmony, at the same time furnishing what was stated to be a further requisite, an independent projection for each rib.

Given the height and width of the arch required, the centres were found in every instance independently, and with mathematical precision. On the width and height of the arch construct a right-angled triangle. From the line, A C (fig. 1) drop a perpendicular to the point B. From C to E will

Fig. 1.

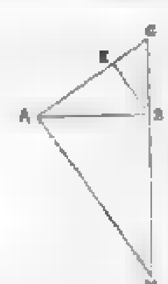
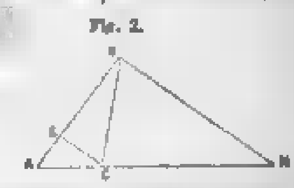


Fig. 2.



furnish the radius of the arch from the impost. Then construct another right angle triangle by drawing A H parallel to E B, and the length of A H added to E C will give the radius for striking the upper portion of the arch. The principle was equally applicable to arches higher than their width, but in this case the second radius will be obtained by the line parallel to E C (fig. 2) being drawn from the upper angle B, and the right angle constructed with B C; which, however, is only added to show that the whole scheme is constructed on one series of angles, the triangles A B C, A E C, and A B H, or B C H being precisely similar in character.

Mr. Laker referred to specimens from Lincoln and Chichester Cathedrals, King's College Chapel, and Crosby Hall, which were referable to his principle, and he showed a diagram of the ribs of groin constructed on this principle, adapted to the angle of the nave and transept of Salisbury Cathedral.

The Vice-President thanked Mr. Laker for his paper, but was more disposed to trust to taste than mathematics.

Mr. Frank Howard was glad to find another fellow-labourer in the endeavour to reduce beauty of proportion to mathematical precision; Schlegel had observed, that there were a certain class of persons who studiously veiled their remarks in indefinite terms, that they might not be called on to support any position they might have taken up. Mr. Howard would condense what might be collected from the rest of Schlegel's works—that the class of critics objected to strict definition of what was good or bad, for fear they should be found on the wrong side. He would ask, "What is taste but an appreciation of that beauty which is acknowledged by the mass of mankind?" The problem to be solved was, in what did that beauty consist? He was quite prepared to admit Mr. Laker's principle as one means of solution, as regarded the striking Gothic arches, but would not like to pledge himself to its being the *only* mode of obtaining beauty therein.

An animated conversation then took place, in which Mr. Duncan, Mr. Goodall, and Mr. Huggins expressed their opinions that it would fail when practically applied to vaulting, the curves for which they could only be practically obtained by a regular curve and co-ordinates, so as to produce conic sections.

Mr. Boult was of opinion that Mr. Laker and Mr. Howard were desirous of carrying a good principle too far; and, while he agreed with a great deal of the paper just read, he could wish to see a model of a groin constructed upon the principle propounded, and the several arches struck on

paper, and cut out so that they could be applied to test the ribs of the model. In this way they would be able to judge of the effect of the groin thus constructed, and, at the same time, to be satisfied as to the mode of striking the arches.

Mr. Barber repeated that he thought the beauty must depend upon taste and not upon rule. He would say to the students, "Cultivate your taste."

Mr. Laker, in reply, stated that it was admitted in all works on architecture that rules were required, but that no rule had yet been laid down for the striking the arches in question. He suggested his method as meeting all the requisitions. If any other could be found he would be very glad to see it.

INTERRUPTION TO THE RIVER CLYDE NAVIGATION.

The steam-ship *City of Glasgow* started out on her final voyage for America from the Clyde on Saturday the 12th inst., leaving the Broomielaw at half past eleven o'clock, p.m. On getting the length of Erskine, she grounded, and on floating again, during the night, only got the length of Bowling Wharf, where she remained till next forenoon, for reasons which we will presently explain.

We must preface that the bank she first rested upon is an accumulation of sand, that regularly, every two years and a-half, gathers at a well-known spot, near Erskine Ferry, where the *dyke* of the river Clyde, on the south side, is not continued for a length of about three miles. It is in consequence of the non-continuance of this dyke that the bank arises, and will continue to arise, till the gap in the dyke be filled up, and the scouring properties of the tide made available for the deepening of the channel, same as at other parts of the river. The removal of this bank costs the Clyde Trustees about 3000*l.* every two years and a-half, or at the rate of about 1200*l.* per annum, not to speak of the loss to the shipping trade by the detention and damage done to their vessels by it.

We now come to the reasons for the *City of Glasgow* being a second time detained, and they are these:—At the end of the gap in the river dyke, or a little below it, there is another bank, which is likewise formed every two years and a-half exactly upon the principles as that of the upper one, with this difference, that whereas the gap at the upper end precipitates the sand on the ebbing of the tide, that at the lower end acts with a similar result on the flowing of the tide; the expense for the removal of said obstacle to the Trustees being likewise about 3000*l.*, or, together, the two incumbrances cost the public about 2400*l.* per annum, exclusive of other disadvantages already alluded to. But it so happens, that when a vessel grounds during the day on the upper bank, and lies till the flowing of next tide, though she should have sufficiency of water, on floating, to get her over the lower one, she has not daylight to do so, particularly in winter, and hence if the night be stormy or dark, or otherwise unpropitious—and ten chances to one but it is so at this season of the year—she is necessitated, under the pilot's orders, to remain another tide, whatever be the views of the master, or the urgency of the voyage.

Now who is to blame for this? Not the River Trustees; for, time after time, they have endeavoured to get power by their several Acts to continue the river dyke for the three miles alluded to. Not the engineers of the trust, for they have as often borne testimony to the necessity of such a dyke; but simply the Lords of the Imperial parliament, who, for the mere gratification of one of their number owning the property that bounds the river at that quarter, and whose eyesight would be disturbed by the appearance of said dyke, were it formed, resolutely refuse powers to the Clyde Trustees to construct such a work, and thus entail upon the public all the expense alluded to; upon the shipping trade all the detention and difficulties pointed out; and upon the merchant and passengers, all the disadvantages and drawbacks that may be conceived, but which to enumerate would be a Herculean undertaking.

Talk of the improvements of the Clyde! Let us rather be silent, while contemplating the ease with which a sandbank can be removed compared with a Peer's prejudice.—*Glasgow Advertiser.*

DOVER HARBOUR OF REFUGE.

Divers succeeded on Thursday, the 17th of October, in fishing up out of eighteen feet of water one of the valuable diving bells out of the three that were sunk and employed in the construction of the great packet pier, which, after three years' labour, has been carried out 650 feet into the sea. It is eventually to be carried out 800 feet. None of the masonry of the pier has been injured, but all the travelling cranes and the huge piling were drifted out to sea. Deane, the diver, who was employed on the wreck of the *Royal George*, is to be here to raise the other diving bells, which weigh about five tons each. Mr. Burges, the representative of Mr. Walker, the government engineer, was down to superintend the operations. There are 200 men employed by Messrs. Lee, the contractors, on the works, and it is expected that on all the apparatus being recovered they will resume work in a fortnight. About 700 acres of sea room are to be taken in to make the harbour, and this will occupy another three years. It is now understood, that should most of the machinery and apparatus be recovered uninjured, the damage, which was confined to it alone, and which has been greatly exaggerated, will be under 4000*l.* The diving bell got up is uninjured.

We have received the following from a correspondent at Dover, in addition to the details before given. The late gale has done much damage to the works in progress for the Harbour of Refuge here; and although the masonry is not injured on the new pier, nevertheless the piles are so broken, and the framework used for the diving bells and placing the blocks of stone and concrete are so broken and disarranged, that it will cause great delay in the completion of the western pier; and the loss will be very great to the contractors—not less than 10,000*l.* The beach on the eastern side of the old pier was literally covered with the fragments of piles and timber; and nobody could pass the wreck without contemplating on the awful power of the wind and waves. The sea seems to have torn asunder the large timbers firmly bolted together, as if they were a baby's toy; and judging from the Cob at Lyme Regis, it is pretty clear that if the masonry had been completed a greater distance out in deeper water than it was, that it would have given way and made a break through the 50-feet in width structure. The pier, as far as it has gone, has had a very good effect on the harbour, as it keeps the entrance free of shingle, and it calms the heavy sea that would otherwise make it difficult for a vessel to enter in such a gale. On the other hand, it seems to have a bad effect upon the eastern side of the old pier, as the sea rolls in heavier, and the water has become more shallow, so much so that pilot boats cannot anchor close in as formerly. Much as this grand project of a harbour of refuge at Dover is to be admired, it is still very doubtful how far the plan is good. The anchorage is not good; it is a flat rocky ground; the new work may cause the whole to fill up. Would it not have been a better plan to have selected a place where there was deep water close to, and have excavated a harbour out of fifty acres of the solid earth by means of locomotive engines and machinery?

VICTORIA DOCKS.

The Victoria Docks will occupy a vast tract of land, extending across the marshes in front of the town of Woolwich. One entrance will be in the Gallions, the other in that reach of the river, known by the expressive but not very euphonious title of Bugsby Hole. The main water channel therefore will extend entirely across the marshes, (forming what is now called North Woolwich into an island,) and being nearly three miles in length. The only point at which it will intersect the North Woolwich Railway, will be at a point near Blackwall, where the upper lock will be crossed by the railway, on an incline varying from 1 in 100 to 1 in 200. The breadth of the dock will average about a quarter of a mile, but the limit of deviation extends to double this distance. To afford some idea of the enormous magnitude of this undertaking, it will be sufficient to adduce the comparison used by the projectors of the company. The entire water area occupied by the various docks on the northern and southern banks of the Thames, amounts to 211 acres; the water area of the Victoria docks will extend to 270, being considerably more than the area of all the other docks put together. The number of ships which entered the existing docks, in 1848, was 4,915, with an aggregate of 1,172,707 tons. The Victoria Docks alone will afford accommodation for nearly six thousand vessels, with an aggregate of nearly one million four hundred thousand tons.

The plans of the Victoria Docks are exceedingly comprehensive, and the detail of the arrangements is as perfect as can be conceived. It is the first example of the application of a scientific and well-methodised plan to a great commercial enterprise. The extended plans show three large docks for the accomodation of shipping, as well as a half-tide dock, with one canal running through the entire line and connecting the four docks together. It is at first proposed to excavate only one dock and the grand canal, leaving the remaining docks to be excavated as necessity shall arise. The first peculiarity to which our attention is directed, is the formation of a double entrance lock, the one of smaller dimensions, adapted for barges, and other small craft; the other much larger and fitted for vessels of the greatest size. This arrangement, which exists in no other docks, has advantages too manifest to be descanted upon. It admits of the exit and entrance of small craft at all times, with the smallest possible loss of water, and the smallest exertion of force. Another grand provision is, the construction throughout all the docks of landing stages, projecting into the water, and enabling a much larger number of vessels to be accommodated than could be provided for with ordinary quays. On these landing stages, lines of rail with turn-tables are laid down, so that merchandise can be landed at once from the vessel on to the truck that is to convey it to the metropolis. These lines communicate directly with a line of rails traversing the docks, which in their turn run at once into the main line of the North Woolwich Railway. The cranes and other machinery will be worked by steam power, and attached to to each of the principal docks will be graving docks for the repair of vessels. It is almost impossible to conceive of plans more unique, more comprehensive, or more perfect than those which Mr. Bidder has put forth for these docks.

Up to the present moment, the progress made in the construction of the docks has been confined to the operation of boring, to ascertain the amount of water made by the land springs, in order to provide the engines necessary for keeping the ground clear during the progress of the excavations. The engine has already been purchased, and early in the spring the work of construction will be commenced with great vigour and prosecuted to completion.

ART IN MUNICH.

A GREAT festival of the artists and artisans had been for some time in active preparation, but the unpropitious state of the weather on the 3rd instant, prevented its full external development. Still the many persons present on this occasion were fully recompensed by the view of one of the chief art-undertakings of the modern German school—we mean the Niebelungen frescoes of Schnorr, on the ground-floor of the New Palace at Munich. It is much to be regretted, however, that the artist has been prevented of late, by a complaint in his eyes, from attending to his work with his usual vigour; still he has been most efficiently assisted by Director Jäger of Leipsic, whom he had already employed in a similar way in the Emperor's Halls of the same palace. The pictures offered to view on the above occasion, were the so-called Saloon of Vengeance, and represent the strife of the Niebelungen with the Huns. The colours of the walls on which they are painted, is scarlet decorated with gold. In the midst of the ceiling are to be seen the prophetic Nereides, in the act of foretelling the events to the hero, whose coats of arms surround the picture. On the minor compartments of the ceiling, Queen Chrimhild is represented calling the warrior Huns to her aid, &c. The Lunettes contain four other pictures of similar subjects. We see Hagen, the monk, thrown overboard, as he was to be the only one saved, according to prophetic foresight. The four great pictures on the walls are said to be the best Schnorr ever executed, as for instance the contest on the burning staircase of the palace, a work full of poetical composition and grandeur.

On the 7th instant, died Charles Schnorr, Professor at the Royal Academy of Arts, thus following soon his friend Rottmann. It is to be regretted, that he has not been able to finish the great picture of the Flood, made by order of King Louis of Bavaria.

The number of fires has been so great last year, that according to a notice of the Minister of Public Works, the income of the Insurance Office, amounting to 944,000fl., is not sufficient to pay the premiums; and an additional per centage is to be levied on the contributories.

ART ON THE RHINE.

THE Gothic church of the Minoresses, at Cologne, erected about the year 1220, and consequently coeval with the superb Cathedral, has hitherto been allowed to fall into a state of great decay, as all the care was absorbed by the larger building. It had long been used as an oratory by the Administration of the Poor, but lately surrendered to the Society for the Improvement of Churches. It is one of the finest specimens of pure Gothic architecture, and the restoration has begun by the rebuilding of the lower gallery of the choir, which almost threatened destruction. On the 1st of October an appropriate public festival took place, when the foundation stone for the thorough restoration was laid, which, when completed, will add to the many architectural curiosities of this ancient city on the Rhine.

The south portal of the Cathedral of Cologne has received some additional ornaments in the five statues representing the Saviour and four apostles, which have been placed in the perforated gable. They are from the atelier of the sculptor Mohr, who has also made the ornaments to the cenotaph of Conrad von Hochstitten in the cathedral. The painter, M. Levy Elken, is preparing a new work—the laying of the foundation stone of that edifice, A.D. 1220.

The annual Art Exhibition at Dusseldorf has just concluded, and is considered to have been a very good one. M. Oer's picture, the death of Tasso in the Convent of St. Orafico at Rome, and M. Valkhart's Knox before Mary Queen of Scots, are most praised. In sculpture, nothing worthy of notice has been produced.

Some idea may be formed of the throng of articles which London will experience during the Exhibition of 1851, by the fact that at the Committee-rooms of Dusseldorf on the Rhine, from that single district of Rhenish Prussia, *two hundred and fifty* persons have already inscribed their names as exhibitors.

BERLIN.—It is stated that the collection of portraits of celebrated contemporary men of that capital formed by the king in his palace there has been transferred to the Marble Palace at Potsdam. This collection, to be increased from time to time, now contains the portraits of Baron Alexander de Humboldt, MM. de Schelling, Godfrey Schadow and Rauch, Baron Cornelius, Meyerbeer, Louis Tieck, Ritter the geographer, Leopold de Buch the geologist, and Ideler and Bessel the astronomers.—*Athenæum.*

PARIS NOTES.

ROAD STATISTICS OF PARIS AND LONDON. — The report of M. Darcy, divisional inspector of the Ponts et Chaussées, who has been to England to obtain information relative to the macadamised roads, has just been published. In this work we find the following particulars relative to the population, extent of the streets, &c. in Paris and London:—The total surface of London is 210 millions of square mètres; its population, 1,924,000; number of houses, 260,000; extent of the streets, 1,126,000 mètres; extent of the streets, not including the foot pavement, 6 millions of mètres; extent of the sewers, 630,000 mètres. The total surface of Paris is 34,379,016 square mètres; population, 1,053,879; number of houses, 30,526; extent of the streets, 425,000 mètres; surface of the streets, exclusive of the foot pavement, 3,000,000 square mètres; length of the sewers, 135,900 mètres; surface of the foot pavement, 888,000 mètres. Thus, in London every inhabitant corresponds to a surface of 100 mètres, at Paris to 34 mètres. In London, the average of inhabitants for each house is 7½; at Paris 34. At London the average of length for each house corresponds to 40m. 40c.; at Paris to a length of street of 15 mètres. These details established the difference which exists between the two cities, from which it appears that there is in London a great extent of surface not built over; that the houses are not very high, and that almost every family has its own. The Boulevards of Paris is the part where the greatest circulation takes place, and the following are the results of the observations of M. Darcy on this subject. On the Boulevard des Capucines there pass every twenty-four hours 9,070 horses drawing carriages; Boulevard des Italiens, 10,750; Boulevard Poissonnière, 7,720; Boulevard St. Denis, 9,609; Boulevard des Filles du Calvaire, 5,858; general average of the above, 8,600. Rue de Faubourg St. Antoine, 4,300; Avenue des Champs-Elysées, 6,959. At London, in Pall Mall, opposite the Queen's Theatre, there pass at least 800 carriages every hour; on London Bridge not less 13,000 every hour. On Westminster Bridge the annual circulation amounts to not less than 8 millions of horses. By this it will be seen that the circulation in Paris does not come up to one-half of what it is in the macadamised streets of London.

SEWERAGE OF PARIS.—From the report of M. Darcy, quoted above, it also appears that there are 135,900 yards of sewers in Paris and without the walls, without including 4600 metres of private sewers; most of these sewers are cleaned twice a-week, some only once, and some few require to be visited every day. The number of workmen employed per day is 90, and the expense of the whole service is 122,511f. a-year. The sewers are in a good state, and may be passed through without danger to the health at any time. In the removal of mud, &c., from the streets there are employed every day on an average 346 carts, 529 horses, and 95 asses; the quantity of matter amounts to about 700 cubic yards, and it is conveyed to at least 2000 yards from the Barriers. There are at present 1784 water-plugs, from which water flows three hours a-day to wash the gutters; they give altogether 1784 quarts of water per second, and others are to be established. The streets watered in Paris, including the promenades in the Bois de Boulogne, are 860,000 yards in extent; if all the paved streets were watered the extent would be 3,000,000 yards. The number of water-carts employed is 106; and the expense is 151,876f. a-year. The total cost of the sanitary operations in Paris is 2,663,000f., or 2f. 66c. for each inhabitant.

SECURITY OF BRIDGES IN PARIS.—A commission of engineers connected with the Board of Roads and Bridges, have examined the suspension bridges of the Invalides, de la Cité, de la Reforme, and de Constantine, by special order. The report speaks of their generally good state of repair, but recommends the making of experiments at the Reforme and Constantine bridges, for testing the solidity of the chains and platforms. An expedient has been recommended, which, if put in practice, will prevent many serious accidents. It consists in the construction of strong gates of iron or timber at the entrance of suspension bridges, and the appointment of special officers whose duty it would be to close these gates, as often as the thronging of too great numbers of people might threaten the rupture of the suspensory chains. It is also projected to erect, in lieu of the present Pont de la Reforme suspension bridge, one of stone; and plans have already been sent in. As the clearing of the space before the Hotel de Ville and the Rue de Châlons are soon to be effected, the providing for the crossing of a greater number of foot passengers and carriages, at this part of the Seine, will have become absolutely necessary.

IMPROVEMENTS IN PARIS.—The so-called Hôtel de Nantes, which since the time of the Consulate obstructed the fine space between the Tuileries and the Louvre, has at last disappeared, and no more than one week was required for this purpose. With a similar celerity, the structure in the gardens of the Palais Royal has risen out of the ground, which is destined for the exhibition of pictures of living artists.

In the Court-yard of the Palais Royal, a large temporary wooden building is being erected to serve for the next exhibition of modern paintings to be held next December.

Among other large operations is the alteration of the prison of La Force, which is under the direction of M. Gibier, architect, of Paris. It is now completed and being occupied. Being arranged for a house of detention for prisoners waiting for trial, it provides for 1200 cells, in which the inmates can be separately kept. It is said to be the first of the kind tried in France to any extent. In France, separation is enforced before trial; but after conviction. in the jails and the hulks the prisoners are allowed to associate. The arrangements in La Force are taken from the last English, American-English, and Netherlandish models; and the contrivances for warming and ventilation are said to ensure perfection.

Among the enterprises now in progress, we may mention the publication of the Encyclopedie d'Architecture, by M. Victor Calliat, architect. It is to include every practical department and detail, as masonry, carpentry, marble-work, iron-work, cabinet-work, plumbing, furniture, &c.; and will be so far of universal use that it will consist chiefly of plates, with very little text. Some of these plates we have seen, and are favourably impressed with the prospects of the work. The work will be a kind of journal, appearing in parts and with illustrations. It will be published on the 1st and 15th of each month; and will contain in each part five engravings. The subscription is about a pound a-year. M. Calliat is the architect who published the magnificent works, the 'Hotel de Ville' and the 'Parallele des Maisons de Paris.'

A railway arcade, similar to that of the Lowther Arcade, in the Strand, is being constructed by the South Eastern Railway Company, on the left hand side of the approach to their terminus on the property in their possession, abutting upon Tooley-street. The design is rather an elegant one, and consists of a succession of shops on either side for the sale of fancy and other articles in requisition by railway travellers, with a large refreshment-room in the centre of the thoroughfare which fronts the railway terminus. The building, between 100 and 200 feet in length, has its basement in Tooley-street, from whence it rises upwards of 60 feet, divided into two stories of 30 feet each, the upper elevation forming the arcade on a level with the railway, and the lower part in Tooley-street forming a range of ordinary shops. There are rooms above the shops, and the floors throughout the building are fire-proof. The front is to be in the Italian style of architecture, and the building, upon which a large number of men have been at work for the last two months, is to be completed and opened by Christmas.

PRUSSIA.—The *Prussian Moniteur* has published a statistical statement of the railway works of that country, from which it appears that 21 undertakings, comprising a length of 204 miles of communication, were open for through traffic in 1849. These railways conveyed 6,597,948 passengers, and 33,813,793 quintals of merchandise. The gross receipts represented 10,782,937 thalers, and the expenses were 5,443,128 thalers, leaving a surplus of 5,339,809 thalers. The capital employed in the construction being 139,740,000 thalers, the return in 1849 was 3·82 per cent. In 1848 the return was stated to have been 3·25 per cent. In 1847 4·32 per cent.; in 1846 4·97 per cent.; in 1845 4·62 per cent., and in 1844 4·74 per cent. The whole of the railways by the works executed in 1849 were augmented by about 20 miles. There are at the present time in progress of construction six other undertakings—namely, the Eastern Railway, those from Westphalia and from Saarbruck, enterprises solely at the government expense, and those from Aix la-Chapelle to Dusseldorf from Ruhrort Crefeld and to Gladbach, and from Aix-la-Chapelle to Maestricht, constructed by private companies. When these new lines shall have been completed, the whole network of Prussian railways will comprise a length of 440 miles.

RAILWAY TUNNEL AT SIENNA.—Letters from Sienna of the 10th ult. give an account of the inauguration of that section of the Sienna Railway which passes through the tunnel at Monte Arioso, one of the most extraordinary constructions of the kind, due to the talent of the celebrated engineer, Professor Pianigiani. The prefect of Florence, the Royal Commissary of Railways, and Count Serristori, the late minister, were present at the ceremony. The train moved slowly along the tunnel, stopping under the most elevated shafts, before the principal springs of water, and before the spot where flames are seen issuing out of the earth. The train, on leaving the tunnel, was enthusiastically cheered by the numerous spectators who had assembled to witness the scene.

LIST OF NEW PATENTS

GRANTED IN ENGLAND FROM SEPTEMBER 26, TO OCTOBER 24, 1850.

Six Months allowed for Enrolment unless otherwise expressed.

James Hamilton, of London, engineer, for improvements in machinery for sawing, boring, and shaping wood.—September 26.

Charles Harratt, of Royal Exchange-buildings, London, merchant, for improvements in rolling iron.—September 28.

Joseph Burch, of Craig Works, Chester, printer, for improvements in printing terry and pile carpets, woollen, silk, and other materials.—September 28.

Joseph Crossley, of Halifax, carpet manufacturer; George Collier, of the same place, mechanic; and James Hudson, of Littleborough, printer, for improvements in printing yarns for, and in weaving carpets and other fabrics.—September 28.

Cyprien Theodore Tisserenc, of Paris, France, gentleman, for certain improvements in hydraulic clocks.—October 3.

Jean Pierre Paul Amberger, of Paris, France, civil engineer, for certain improvements in the application of magnetic power for moving and stopping carriages, for giving adherence to wheels upon rails, and also for transmitting motion.—October 3.

William Tudor Mabley, of Manchester, patent agent, for certain improvements in the manufacture of soap. (A communication.)—October 3.

William Boggett, of St. Martin's-lane, Middlesex, gentleman, and William Smith, of Margaret-street, in the said county, engineer, for improvements in producing and applying heat, and in engines to be worked by steam or other elastic fluid, which engines are also applicable as pumps.—October 3.

Julian Bernard, of Buchanan-street, Glasgow, artist, for improvements in pneumatic springs, buffers, pumps, and stuffing boxes.—October 3.

Charles Bury, of Salford, Lancaster, manager, for certain improvements in machinery or apparatus for preparing and spinning, doubling or twisting silk waste, cotton, wool, flax, or other fibrous substances.—October 10.

Charles Bury, of Salford, Lancaster, manager, for certain improvements in machinery or apparatus for cleaning, spinning, doubling, and throwing raw silk.—October 10.

Robert Beart, of Godmanchester, for improvements in the manufacture of bricks and tiles.—October 10.

John Scott Russell, of Great George-street, Westminster, engineer, for improvements in the construction of ships or vessels propelled by paddle-wheels, with a view to better stowing the same.—October 10.

William Wood, of Over Darwin, Lancashire, carpet manufacturer, for improvements in the manufacture of carpets and other fabrics.—October 10.

William Henry Ritchie, of Kennington, Surrey, gentleman, for certain improvements in machinery for preparing and carding fibrous substances. (A communication.)—October 10.

William Edward Newton, of Chancery lane, engineer, for improvements in manufacturing yarns. (A communication.)—October 10.

James Hamilton Browne, of the Reform Club, Pall-Mall, Esq., for improvements in the separation and disinfection of fecal matters, and in the apparatus employed therein. (A communication.)—October 10.

William Francis Fernihough, of London, engineer, for improvements in locomotive and other steam engines, and improvements in obtaining motive power.—October 10.

Whiting Hayden, of Windham, Connecticut, United States of America, for an improved regulator or apparatus for regulating the draught of the sliver on the machine, termed the "drawing frame."—October 10.

Adolf Frederick Gurlt, of Manchester, gentleman, for an improved method of extracting silver from argentiferous minerals.—October 10.

George Michiels, of London, gentleman for improvements in treating, and preparing potatoes for seed. (A communication.)—October 17.

John Fowler, jun., of Melksham, Wilts, engineer, for improvements in steam-engines, in raising and forcing fluids, in irrigating and draining land, and in machinery for cutting wood for drain-pipes, and other uses.—October 17.

Daniel Towers Shears, of Bankside, Surrey, copper merchant, for improvements in the manufacture and refining of sugar. (A communication.)—October 17.

John Robert Johnson, of Crawford-street, chemist, for improvements in fixing colours on fabrics made of cotton and other fibre. (A communication.)—October 17.

James Henry Baddeley, of Shelton, Stafford, engineer and designer, for improvements in the manufacture of ornamental articles of earthenware.—October 17.

Thomas Richards Harding, of Lille, France, manufacturer, for improvements in machinery for heckling and carding flax in machinery, for combing and drawing wool and other fibrous materials, and in machinery for making parts of such machines, and for a new arrangement of the steam-engine for driving flax and woollen mills, which arrangement is also applicable to other purposes where motive power is required.—October 17.

Henry Bernoulli Barlow, of Manchester, consulting engineer, for improvements in spinning cotton and other fibrous materials.—October 17.

James Henry Williams, of Birmingham, manufacturer, for certain improvements in the manufacture of buttons.—October 17.

James Young, of Manchester, manufacturing chemist, for improvements in the treatment of certain bituminous mineral substances, and in obtaining products therefrom.—October 17.

Jean Louis Pascal, of Moorgate-street, London, civil engineer, for an improved apparatus for the cure or prevention of smoky chimneys, and also for the ventilation of ships, rooms, and buildings in general.—October 24.

Thomas Beale Browne, of Hampen, near Andoversford, Gloucester, gentleman, for improvements in weaving and preparing fibrous materials, and staining or printing fabrics. (A communication.)—October 24.

Alexander Dixon, of Abercorn Foundry, Paisley, for improvements in moulding iron and other metals.—October 24.

John Mercer, of Oakenshaw, within Clayton-le-Moors, Lancashire, gentleman, for improvements in the preparation of cotton and other fabrics and fibrous materials.—October 24.

John Oliver York, of Boulogne-sur-Mer, France, for improvements in the mode or manner of generating steam in locomotive, marine, and other boilers.—October 24.

John Grant, of Hyde Park street, Middlesex, for improvements in heating and regulating temperature.—October 24.

Aaron Rose, of Halesowen, Worcester, manufacturer, for a certain new or improved method or certain new or improved methods of manufacturing twisted gun and pistol barrels.—October 24.

Samuel Jacobs, of Highgate Kendall, Westmoreland, cabinet maker, for certain improvements in printing on woollen, cotton, paper, and other substances, parts of which improvements are applicable also to the purposes of colouring, shading, tinting, or varnishing such substances.—October 24.

Bryan Millington, of Brant Broughton, Lincoln, and of the firm of Millington and Sons, of Newark-upon-Trent, Nottingham, millers, for improvements in corn-cleaning and flour dressing machines.—October 24.

Edward Clarence Shepard, of Parliament-street, Westminster, gentleman, for certain improvements in electro-magnetic apparatus, suitable for the production of motive power, of heat, and of light. (A communication.)—October 24.

LECTURES ON THE HISTORY OF ARCHITECTURE,

By Samuel Clegg, Jun., M.I.C.E., F.G.S.

Delivered at the College for General Practical Science, Putney, Surrey.

(PRESIDENT, HIS GRACE THE DUKE OF BUCCLEUCH, K.G.)

Lecture XI.—ROME: *Domestic Architecture.*

It is to be regretted that so little is positively known on the subject of Classical Domestic Architecture. This want of information is however the less surprising, when we consider that the Greeks and Romans were not a domestic people, and that most of their time was spent in public; besides, private residences, however wealthy the community may be, are seldom built with the same solidity as public edifices, and therefore the sooner go to decay. The great changes also that take place in domestic manners, render the habitations of one period unfitted for subsequent times; they are therefore either removed to make way for new dwellings, or so altered as to lose much of their original character: this must have been more especially the case in the great revolution that took place in manners and customs on the spread of Christianity and the dismemberment of the Roman Empire. But notwithstanding the idea of what was necessary and comfortable amongst the ancient Romans differs as widely from ours as does our domestic life from theirs, it is neither uninstructive nor uninteresting to inquire into their mode of living; for as each receding tide leaves some vestige behind it on the shore, so the manners and ideas of past ages have left traces that may be recognised in the present day.

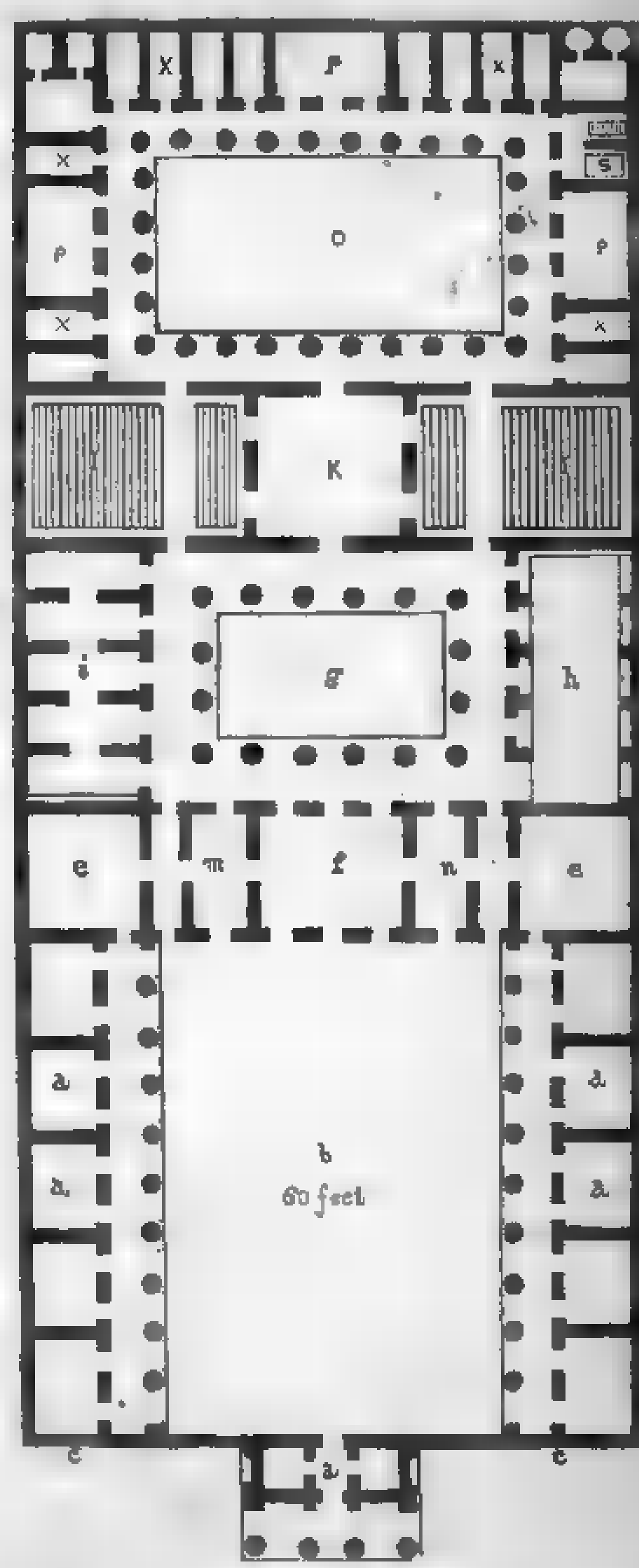
If it had not been for the discovery of Pompeii, we should have been wholly indebted to the descriptions gleaned from various authors for our knowledge of Roman domestic architecture. This little town (buried for 1600 years) played no conspicuous part in history; and had it not been for its singular and unfortunate fate, would probably have utterly sunk into oblivion. The dwelling-houses found there may therefore be supposed to be small and insignificant compared with those of Rome, and other important cities; but still they are doubtless arranged on a similar plan, and prove a great assistance in forming an idea of the private habitations of the Romans, and their style of interior decoration.

For several centuries after the foundation of Rome, the houses were only thatched and covered with shingles; and the laws of the ædiles forbade the walls of private dwellings to be made above eighteen inches in thickness. During the time of the Commonwealth, the Romans were extremely jealous of any attempt made by a citizen to exceed his neighbours in show or style of living. Publius Cornelius Rufinus, though he had been twice consul and once dictator, was removed from the senate on account of the purchase of some silver vases. So little silver was there in Rome at this time, that when an entertainment was given by a senator, the rest of the body were accustomed to lend their plate for the occasion. Lucius Crassus was made to pull down his house on the Palatine Hill, because the roof of the atrium was supported by four columns of foreign marble—an unheard of luxury! It was owing to this atrium, that Brutus used to call him in derision, "the Palatine Venus." Even Julius Cæsar had to obtain permission to construct a pediment to his house, as this was considered a peculiar mark of distinction. Cicero says: "If you could build in heaven, where you have no showers to fear, yet you would never seem to have attained dignity without a pediment."

When Rome ceased to be a republic, all these restrictions were done away with, and the wealthy citizens of Rome seem to have vied with each other in the sumptuousness of their dwellings. The wealth of the world poured into the imperial city; it was no uncommon thing for a Roman patrician to receive as much as was equal to 160,000*l.* per annum from his estates, besides corn, wine, oil, and other produce. Some of these landowners are said to have possessed as many as fourteen villas in different parts of Italy, as well as a mansion in Rome. A favourite site for these luxurious villas was the beautiful shore of the bay of Naples: so splendid were those in the neighbourhood of Baiæ, that when Aristobulus, king of Judea, landed there, he imagined himself already in the capital of the universe.

Rome at one time contained 48,382 houses (including the two classes of insula and domus), ranging from the magnificent palace to the miserable, ill-lighted, and ill-ventilated lodging-house, where the poor congregated. Houses were raised to an inconvenient height, to afford shelter within the walls to the dense population; it was enacted first by Augustus, and afterwards by Nero, that no private house should exceed 70 feet in height from the ground, a law, however, that appears to have been frequently evaded. Many parts of the city were so crowded, that fearful plagues occasionally broke out; a pestilence that occurred in the

Plan of Roman Mansion.



References to Engraving.

a, Vestibulum; *b*, Atrium; *c c*, Alæ; *d d*, Cellæ familiaricæ; *e e*, Courts of the Offices; *f*, Tablinum; *g*, Cavædium; *h*, Exedra; *i*, Bibliotheca; *k*, Cyzicene Oecus; *l l*, Gardens; *m*, Pinacotheca; *n*, Rooms for embroidery; *o*, Peristyle; *p*, Vernal triclinium; *q*, Summer triclinium; *r*, Winter triclinium; *s*, Cold bath; *t*, Tepid bath; *v*, Warm bath; *w w*, Sudatories; *x x*, Cubicula.

reign of Titus is said to have carried off 10,000 persons daily. The wealthier classes buying up the land on which to build their mansions, and lay out their extensive pleasure-gardens, ground and, consequently house-rent, became enormously dear. In the time of Augustus a single suite of rooms in an insula, or detached house, was valued at 40,000 sesterces, between 300*l.* and 400*l.* per annum. It was intended by Nero, on the rebuilding of Rome, that each house should be an insula; but this was only partially carried into effect.

We know little about the plan or elevation of these mansions: they were probably as varied as in modern buildings. They appear to have been surrounded on three sides by colonnades fronting the streets, and occupied by shops for the sale of the produce of the estate and other commodities; but as trade was considered degrading, the sale was entrusted to freedmen, or slaves, or the shops were let, and brought a considerable rental to the proprietor of the insula. These Roman mansions must have contained a multitude of apartments, as each patrician entertained a train of clients and dependents, besides his servants and slaves. They were built around open courts, like those of the East in the present day, and had few or no windows looking towards the street.

Though, as before observed, the houses were, no doubt, various in plan, it will save confusion in describing the principal courts and chambers they contained, to follow that given by Vitruvius. First, on entering the portico, was the *Vestibulum*, or vestibule; this apartment was generally circular, and derived its name from the goddess Vesta, to whom it was dedicated; it was also sacred to the Lares, whose statues were placed in niches round the wall. Pavements have been found belonging to this part of the house, with the words "*Cave canem*" (beware the dog) formed in mosaic: this might seem to reflect upon the hospitality of the ancient Romans; but the image of a dog barking was generally placed at the foot of the statues of the Lares familiares, to denote their vigilance: the caution, therefore, might be merely a warning against offending the household gods. The Lares were supposed to be the spirits of deceased ancestors, hovering about their former abode for the protection of its inmates; the word is derived from the Etruscan "*lars*"—a leader or conductor. A festival in their honour was celebrated every May, when their statues in the vestibule were crowned with flowers, and offerings of fruit presented.

The vestibule led immediately into the *Atrium*, a large open court or hall, where visitors and clients waited. Atria are said to have been of Etruscan origin, and so called from the city Adria; they were of several kinds. The Tuscan atrium was square, built simply with four beams crossing at right angles, leaving the central space exposed to the air: when the atrium was so large as to require additional support for the beams, four columns were placed at the angles; it was then called tetrastyle. Corinthian atria were generally circular, larger, and more sumptuously adorned: those called testudine were small, and had a vaulted roof something resembling the back of a tortoise, whence their name. The open space in the centre was called compluvium, through which the rain fall into the impluvium, or tank, below; when the rafters were made to incline the contrary way, so as to throw the rain off outside, the atrium was said to be displuviatum. The atrium being the most public part of the house, was always decorated to the extent of the proprietor's means: with fresco paintings representing mythological subjects, or passages from history, and masterpieces from the sculptor's hand. The statues and busts of the family were also placed here, when the master of the house had a right to possess them; but such a privilege was only granted to those who had borne some high office in the state, and was equivalent to a modern coat of arms;—he who had pictures and statues of his ancestors, was accounted noble. Suits of armour, and trophies of war, were also suspended in the atrium. On each side of this court were porticoes or *Alæ*, leading into the *Cellæ familiaricæ*, or apartments for domestic use. It is supposed that in town houses, the *Culina*, or kitchen, with its accompanying offices, was in this division.

Beyond the atrium, and merely divided from it by a curtain that could be raised or lowered at pleasure, was a sitting-room called the *Tablinum*. On each side of this were apartments devoted to embroidery or other work; or perhaps the picture gallery.

Beyond was the *Cavædium*, a smaller court, built in various styles, like the atrium. The cavædium had generally a fountain in the centre, and the compluvium was occasionally covered with a purple awning, tinging the surrounding objects with a warm hue. Some suppose the cavædium to have been merely the central part of the atrium, but in this plan it is represented as a separate division of the house. On one side is the *Bibliotheca*, or library; on the other are *Exhedræ*, or rooms for reading and conversation. The word *theca* signified any kind of repository—thus there was the biblio-theca for books, the pinaco-theca for pictures; the oporo-theca for keeping apples and other fruits; the apo-theca for general stores; and so on. Vitruvius recommends that the bibliotheca should look to the east; because, he says, "books are better preserved when the air and light are received from that quarter: when libraries have a southern or a western aspect, they admit those winds which, at the same time that they carry with them moths, instil also damp vapours into the books, which in process of time cause their decay." Roman libraries were adorned with pictures and busts of eminent literary men, and were furnished with shelves or drawers, where the locumenta or boxes were placed, containing the precious manuscripts: no wonder so much care was taken in their preservation, as a library in those days must have been an expensive luxury, attainable only by the few.

Proceeding onwards from the cavædium, we enter the *Cyzicene occus*, with its surrounding gardens. This saloon must have been a delightful summer apartment, with its large windows looking over the flowery parterres, and open also both to the cavædium and the peristyle. The occi were of several kinds: the tetrastyle, with the ceiling supported by four columns; or the Corinthian, with engaged columns and windows between; or the Egyptian, consisting of two orders. In this last kind of occus, isolated columns supported a second range of engaged columns, having the intervening wall pierced with windows; above all rose the vaulted ceiling ornamented with coffers. These saloons were made lofty to allow of the free circulation of air, so desirable during an Italian summer. Vitruvius directs that the height of all apartments which are longer than they are wide, should be "determined by making it half the sum of the length and width added together; when a square, the height is made greater in proportion by the addition of half the width." Another rule he gives is, "Take a square, one side the width, the diagonal the length; height to the trabes three-fourths the length." The occus was furnished with triclinia, or couches, so arranged that the guests reclining on them might have a full view of the garden.

The *Peristyle* was another large open court, and, as its name denotes, was surrounded by columns: the Villa Gordiana is said to have had a peristyle of two hundred columns. This court was generally planted with trees and shrubs, and sometimes had a fish-pond in the centre: the low wall, or pluteum, connecting the columns, was hollowed out for the purpose of containing soil, in which flowers were planted. When the curtains of the tablinum and the cyzicene occus were raised, the perspective view of a Roman house seen from the vestibule must have been very beautiful; first, the richly ornamented atrium; then, through the tablinum into the cavædium, with its sparkling fountain; and beyond, the sumptuous occus, with the garden of the peristyle terminating the prospect.

Round the peristyle, and communicating with it, were the more private apartments: the vernal, summer, and winter *Triclinia*, or eating-rooms, appropriated to the different seasons, according to their aspect; the *Cubicula*, or sleeping-rooms, small chambers generally containing a recess for a bed, which was laid on a marble tressel, about six inches from the ground;—and the *Baths*, which were considered an essential in every house, and were arranged similarly to the bathing rooms in the public thermæ.

As the principal apartments of the house were always on the ground floor, there was no grand staircase; where there were upper rooms, they seem to have been chiefly devoted to the females of the family, who, however, did not lead so retired a life as that of the Greek ladies: here also were the *Vestiarii*, or wardrobe rooms, and the *Penetralia*, or sanctuary devoted to the penates, or penetrales, as they were sometimes called; these gods were either deified ancestors, or any of the superior divinities, under whose especial protection the house was supposed to exist.

Occasionally a terrace was formed on the flat roof, where the family met to enjoy the prospect and the cool evening breeze; this terrace was shaded by trellis-work, called pergola, and adorned with creepers and boxes planted with flowers: sometimes an aviary added to its attractions. The numerous slaves were lodged in one common chamber underground, called the *Ergastulum*.

In an early stage of civilisation subdivision of labour was almost unknown, and each household had to be in a great measure self-sufficient, all the principal arts and trades being carried on by its different members. Pignorius mentions more than two hundred kinds of employments that were exercised by slaves or servants in the houses of the great. Each mansion contained a carpenter, blacksmith, &c.; and not only the spinning and weaving, brewing,

and baking, but building and decorating was the work of the household slaves. Where the floors were so generally constructed of mosaic or tesselated marble, the pavimentarii, or slaves skilful in the art of constructing pavements, must have been necessary members of the family. The floors were frequently laid with small bricks placed obliquely upon their edge, so as to form an angle; a kind of work called *opus spicatum*, because the bricks were placed like the grains in an ear of wheat. Sometimes the brick was mixed with bits of white marble, as may be seen in Pompeii. In the more richly decorated apartments a coating of cement was laid, and upon this, mosaics of elegant design in variously-coloured stones. Occasionally, appropriate inscriptions formed a part of the mosaic floor, such as "*Salve*," and in the bed-rooms, "*Bene dormio*." Numerous fine specimens of Roman pavements have been found in every part of their world-wide domain.

In preparing the walls of the rooms for the fresco paintings with which they were decorated, three coats of plaster were used: the first, rough mortar; the second was called arenatum, and was composed of sand and lime, or puzzolano; the third and last coat was called marmoratum, in which pounded marble was used. This was worked and rubbed until a perfectly smooth surface was obtained, and was capable of receiving so high a degree of polish as to reflect objects like polished marble itself. While this marmoratum was still wet, the frescoes were laid on.

The rooms were divided in height by a small cornice, above the door; the upper division being to the lower as two to three. The walls were then divided into compartments, the width of the doorway; these compartments were painted a full deep colour, such as red, cinnamon, dark green, or even black; with the exception of the central medallion, which was occupied by a design in brilliant colours.

The paintings were generally either historical or mythological subjects, or illustrative of passages from the poets; but occasionally landscapes or architectural pieces were introduced; the latter showing a considerable knowledge of perspective. The figure pieces are designed after the manner of bas-reliefs, each figure being independent, without casting shadows one on another: foreshortening was seldom attempted. Occasionally, in smaller compartments, the medallions were brought out in white on an azure ground. Each division or panel was surrounded by a border of elaborate or richly coloured arabesque, displaying an exuberant and graceful fancy. It is difficult to assign an origin to this style of decoration, which the Romans called *ropography* or twig painting: the discovery of the antique frescoes has quite contradicted the idea that it was an invention of the Saracens, or peculiar to Arabian architecture, as the name of arabesque would lead one to suppose. The Romans relied more on the architecture and painting of their rooms, to produce a magnificent effect, than upon the furniture which they contained; upholstery work was almost unknown, as internal decoration was then an art and not a trade.

The art of glazing was evidently known at an early period, as a window of thick greenish glass set in lead, has been found in Pompeii; but this appears for some centuries after to have been an unusual refinement, for Vopiscus mentions glass windows as amongst the luxuries of a wealthy merchant of the name of Firmus, who lived in the reign of Aurelian: a kind of thin stone is described as generally used for windows, called *lapis specularis*, probably talc. Fire-places have occasionally been found amongst Roman remains; but the only chimney appears, in most instances, to have belonged to the kitchen, the rest of the house being heated with hot air.

It is to be supposed that in the various climates through which the Roman empire extended, some variations in the style of domestic building would be found necessary; but none such are discoverable from existing remains.

Of all the splendid palaces erected by the different emperors, few vestiges are left. The Palace of the Cæsars is now only a heap of ruins on the Palatine Hill. The Villa of Hadrian at Tivoli may yet be traced for a circuit of ten Italian miles; it contained theatres, palæstræ, naumachia, thermæ, and every conceivable kind of building for luxury and entertainment. In the library were numerous niches occupied by the finest statues of Grecian workmanship, and a portico near was built in imitation of the Poecile of Athens. The ruins of this villa have proved an inexhaustible mine from which the cabinets of Rome are still enriched, and some of the most beautiful antique frescoes have been found here.

The Domus Aurea, or golden house of Nero, so called from the gilded tiles of its roof, was built on the borders of an artificial lake between the Palatine and Esquiline hills, and was surrounded by extensive pleasure gardens and porticoes. It is said that the wings of the building were united by a gallery a mile in length. In the interior the walls and ceilings were decorated with gold and mother-of-pearl, or set with precious stones; the ceiling of the great banqueting-hall was painted to resemble the firmament, and so contrived as to have a rotatory motion, and to shower down perfumed water. When this palace was completed, Nero observed, that he had now built a house fit for a gentleman. It did not long remain a monument of his extravagance, for it was partially destroyed by Vespasian, and the Coliseum built on its site.

The only palace of the Roman emperors of which enough is left standing to enable us to trace the plan, and to judge from actual observation of its extent and magnificence, is that of the Emperor Dioclesian at Spalatro; commenced A. D. 303. The building occupied twelve years, and, together with the cultivation of his garden, formed the principal amusement of the emperor during his retirement. The plan of this palace is quadrangular, about 700 feet in length by 800 feet in breadth; the walls were flanked by sixteen towers; it was constructed of the beautiful freestone of Tragutium, which is almost as fine in quality as marble: the outer walls are 7 feet in thickness. The building is intersected by two streets at right angles; in the southernmost division were the private apartments of the emperor, and two temples, the one dedicated to Jupiter, the other to Æsculapius, the deities presiding over fortune and health. The former building is now the Duomo of the modern town. It is vaulted, and about 78 feet in height; the dome is constructed in brick-work, and consists of a succession of small arches one over the other, something resembling scales; the roof is covered with tiles, and a floral ornament surmounts the apex: both the temples stood within a temenos. In the great peristyle of the palace, the columns are of granite, and support arches which spring direct from the capital, without any intervening member. The building, though consisting of only one story, was capable of lodging a prætorian cohort. The principal entrance is yet standing, and is still known by the name of the golden gate; over this is a flat arch, composed of indented stones fitting into each other—the first departure from the plain wedge-shaped voussoir. Amongst the decorations in this edifice are seen the rope moulding, and the chevron or zigzag. It is difficult to believe some of the brackets to be of so early a date, so completely do they anticipate the Christian art of after-centuries; especially those supported by the winged head of a child, with the chevron ornament round the mouldings. Few ruins are more interesting than this, as so clearly showing the gradual transition of style.

The country villas of the Romans were in a style of equal magnificence with their town houses; they were divided into three parts: first, the *Prætorium*, or villa urbana, for the residence of the master and his immediate attendants, consisting of the atrienses or household servants, the topiarii or gardeners belonging to the pleasure grounds, the musicians, and the notarius or secretary. Secondly, the *Villa Rustica*, or farm department, where were lodged the procurator or bailiff; the villicus and villica, or husbandman and housekeeper; the master of the cattle; the aviarius or poulterer; and other persons employed on the farm. The third division was called the *Fructuaria*, consisting of storehouses for corn, oil, wine, fruit, &c.

But as much of our information respecting these villas is derived from the writings of Pliny, I cannot do better than make a few extracts from his letter describing his villa at Laurentinum, seventeen miles from Rome:—"My villa, he writes," "is large enough to afford all desirable accommodation, without being extensive. The porch before it is plain, but not mean; through which you enter a portico in the form of the letter D, which includes a small but agreeable area. This affords a very commodious retreat in bad weather, not only as it is inclosed with windows, but particularly as it is sheltered by an extraordinary projection of roof. From the middle of this portico, you pass into an inward court extremely pleasant, and from thence into a handsome hall, which runs out towards the sea; so that when there is a south-west wind; it is gently washed with the waves, which spend themselves at the foot of it. On every side of this hall, there are either folding doors, or windows equally large......On the left-hand side of this hall, somewhat farther from the sea, lies a large drawing-room, and beyond that a second of smaller size, which has one window to the rising, and another to the setting sun......The angle which the projection forms with this drawing-room, retains and increases the warmth of the sun; and hither my family retreat in winter to perform their exercises......Contiguous to this is a room, forming the segment of a circle, the windows of which are so placed as to receive the sun the whole day; in the walls are contained a set of

cases, which contain a collection of such authors whose works can never be read too often. From hence you pass into a bed-chamber through a passage, which being boarded and suspended, as it were, over a stove which runs underneath, tempers the heat which it receives and conveys to all parts of this room. The remainder of this side of the house is appropriated to the use of my slaves and freedmen; but most of the apartments, however, are neat enough to receive any of my friends. In the opposite wing is a room ornamented in very elegant taste; next to which lies another room, which, though large for a parlour, makes but a moderate dining-room......Beyond is a bed-chamber, together with its ante-chamber, the height of which renders it cool in summer, as its being sheltered on all sides from the winds, makes it warm in winter. To this apartment another of the same sort is joined by a common wall. From thence you enter into the grand and spacious cooling room belonging to the bath; from the opposite walls of which, two round basins project, sufficiently large to swim in." He then proceeds to enumerate the different bathing apartments. "At the other end," he continues, "is a second turret, in which is a room that receives the rising and setting sun. Behind this is a large repository, near to which is a gallery of curiosities; and underneath is a spacious dining-room, where the roaring of the sea, even in a storm, is heard but faintly. It looks upon the garden, and gestatio which surrounds the garden. The gestatio is encompassed with a box-tree hedge; and where that is decayed, with rosemary......Between the garden and this gestatio runs a shady plantation of vines, the alley of which is so soft, that you may walk barefoot upon it without injury. The garden is chiefly planted with fig and mulberry trees, to which the soil is favourable, as it is averse to all others. In this place is a banqueting-room, which, though it stands remote from the sea, enjoys a prospect nothing inferior to that view. Two apartments run round the back of it, the windows whereof look upon the entrance of the villa, and into a very pleasant kitchen garden. From hence an inclosed portico extends, which, by its great length, you might suppose erected for the use of the public. It has a range of windows on each side; but on that which looks towards the sea, they are double the number of those next the garden. When the weather is fine and serene, these are all thrown open; but, if it blows, those on the side the wind sets are shut......Before this portico lies a terrace, perfumed with violets, and warmed by the reflection of the sun from the portico......On the upper end of the terrace and portico, stands a detached building in the garden, which I call my favourite; and indeed it is particularly so, having erected it myself. It contains a very warm winter room, one side of which looks upon the terrace, the other has a view of the sea, and both lie exposed to the sun. Through the folding doors, you see the opposite chamber, and from the windows is a prospect of the inclosed portico. On that side next the sea, and opposite to the middle wall, stands a little elegant recess, which, by means of glass doors and a curtain, is either laid open to the adjoining room, or separated from it. It contains a couch and two chairs......Adjoining to this is a bed-chamber, which neither the voice of the servants, the murmuring of the sea, nor even the roaring of a tempest, can reach; not lightning, nor day itself, can penetrate it, unless you open the windows. This profound tranquillity is occasioned by a passage which separates the wall of the chamber from that of the garden; and thus by means of that intervening space, every noise is precluded. Annexed to this is a small stove-room, which, by opening a little window, warms the bed-chamber to the degree of heat required. Beyond this lies a chamber and ante-chamber, which enjoy the sun, though obliquely indeed, from the time it rises till the afternoon. When I retire to this garden apartment, I fancy myself a hundred miles from my own house, and take particular pleasure in it at the feast of the Saturnalia, when by the license of that season of festivity, every other part of my villa resounds with the mirth of my domestics: thus I neither interrupt their diversions, nor they my studies. Among the pleasures and conveniences of this situation, there is one disadvantage, and that is the want of a running stream; but this defect is in a great measure supplied by wells, or rather I should call them fountains, for they rise very near the surface."—A healthy situation, good water, and ready access to Rome, either by land or water, were considered indispensable requisites in selecting a site on which to build.

It must be remembered that the villa described by Pliny was merely a winter residence, and of modest proportions compared with those of the more wealthy patricians. Vitruvius says: "Those of the nobles who bear the honours of magistracy, and decide the affairs of the citizens, should have a princely vestibulum, lofty atrium, and ample peristylium, with groves and extensive ambulatories, besides libraries and basilicas, decorated in a manner similar to the magnificence of public buildings, for in these places both public affairs and private causes are oftentimes determined."

The gestatio, described by Pliny, was a place for horse exercise; the box-trees by which it was bordered were frequently clipped into various forms, like those in an old-fashioned English garden. It was from this custom that the gardeners were called topiarii. The covered and inclosed portico was called crypto-porticus, and was intended for exercise in hot or wet weather; it was what we should call a gallery. A garden apartment devoted to retirement and study, was called a museum, from its being sacred to the muses. Besides the various farm buildings, orchard, kitchen garden, poultry yard, &c., necessary to an extensive country residence, there were belonging to these luxurious villas, warrens for hares and rabbits, and a park planted with forest trees, and containing fish-ponds, and abounding with game of every description. Varro mentions a piece of ground, fifty acres in extent, belonging to Quintus Hortensius, called a theriotrophium, which was devoted to the preservation of wild animals for the chase, such as deer and boars.

The care of the apiary was considered of great importance, and Apicius enumerates snails and dormice as amongst the dishes pleasing to a Roman palate; both of these creatures had places set apart for their nourishment in the villa rustica. When we consider the numerous departments to be attended to, we are scarcely surprised when we hear of three or four hundred slaves being employed on one estate.

We now take our farewell of ancient Rome, with all its magnificence and luxury; and though we may condemn the want of pure taste and inordinate love of ornament, visible in many of the works of Roman architecture, they are at the same time so wonderful in their grandeur and beauty, that every race of architects of every age have approached them not only with admiration but with reverence, as a noble lesson in what the genius of man may achieve.

My next Lecture will be on the Foundation of Constantinople, and the first style of Christian architecture, known as Byzantine.

LIST OF AUTHORITIES.

Vitruvius.—Decline and Fall of the Roman Empire; Gibbon.—Encyclopédie Méthodique.—Spalatro; Adam.—Sir J. G. Wilkinson's Dalmatia.—Essay on Roman Villas; Moule.—Pompeiana; Sir William Gell.—Villas of the Ancients; Castell.—Ornaments from Pompeii; Zahn.

APPLICATION OF HIGH ART TO PUBLIC SCULPTURE.

On the Application of High Art to Public Sculpture, and its relation to the wants of the People. By PATRIC PARK, of Edinburgh.

THE history of art is progression and retrogression. One bright era, the dynasty of Pericles and Phidias, in the sister arts of architecture and sculpture; another, the bright era of the Cinquecento, in painting, sculpture, and architecture; and a third, the era of the immortal Canova and Flaxman in the resurrection of sculpture in modern times—fill our minds from the works these ages have produced, with the positive knowledge that a lofty perception of the works of God and the high destinies of art were then apparent to artists and recognised by the world—a glorious blaze of sunshine, which seems to have put out the eyes of their successors, doomed to a mournful recognition of past splendour they felt themselves unequal to match or even to confront. Devoid of retrospective ambition, their estimate intellectually of the worth of preceding greatness in art is that which is stamped on the mind of the trader by its marketable and commercial value. No doubt in this the master is acknowledged; but, contemptible sons of great sires, they have lived but to exist on the renown of their fathers—forgetful that past glory forgotten or uncultivated, makes present imbecility a crime, not a misfortune.

Having premised that these remarks were necessary in order to introduce the topic he wished to bring before the public attention—that of recalling to practice a standard in high art, the lecturer proceeded to state, as the principle he wished to enforce, that the use of the *nude* is the only means by which certain characteristics in man can be illustrated; and that in combination with it, drapery, from its form and infinite variety, is an adjutant principle of scarcely secondary importance in its appeal to human perception, and this not as robes made after a fashion which have their own individual significance, but as a simple covering, taking its immediate style from the genius of the artist, the necessity of the case, and the character of the subject. We advocate these principles

—the use of the *nudo*, and the *nudo* with drapery—not as belonging to any particular age or country, but as being universal in their tendencies, and appreciable of every nation—by all nations—a double power, by which character is not only illustrated to the nation in which it was produced, but in an equal degree to foreigners without the necessity of a translation. Our advocacy of these principles, however, must be precisely understood to be in their application to a high class of character; the application of truth to deformity or malformation would be to the depression not the exaltation of good feeling. It might give opportunity to malignancy; it certainly would be antagonistic to the genius of high art, which reserves itself as the exponent of that exalted personality which rises far above ordinary humanity—such as the hero of a people, the representative of their patriotism—a character sublimed and deified during a lapse of ages, whose example has during these ages fired the generous minded to excel in personal, and to achieve national, distinction,—whose acts were the theme of poets, whose name was the household word of the peasant,—the spell of victory to his countrymen in battle, their shield and spear to sustain them in misfortune—a legacy of worth of character, not honour which would make a man of the same country degenerate. —This class of character the Greeks deified—of these were the demi-gods of the ancients, and to illustrate which no power exists but the *nudo*. Emperors and kings, on the other hand, being different from the nobility of God's creation, are to be represented in their conventional costume, which is unlike an ordinary dress. It is not an uniform; the royal robes of sovereignty are distinctive of an office, differing in different sovereignties, and they stand in lieu of personal superiority, ever but when in those rare instances mind and intellect emancipate the man from the trammels of station, and bring him within the fluctuations of general life to be the benefactor or the scourge of mankind. We meddle not with this section of art: we merely note our recognition of it to prevent mistake as to our meaning elsewhere; neither do we interfere with that class of character to which private or even corporate esteem dedicates statues. The limits of the sphere of operation which have governed that character must determine how far conventionality is to be followed; or, as in the event of grace and beauty being concerned, the true art should be called upon. These being questions secondary to our present object, can ever be safely left to the individual artist, but in whose mind the true principle ought ever to have a fixed station; as the misapplication of a high standard has done already infinite harm, and no doubt has opposed the progress of truth in the public mind, as the visitors to our public monuments in St. Paul's and Westminster can too truly bear witness.

The lecturer then went on to repudiate the principle that sculptors should execute men for their costume, and that a great art should be made a medium for carrying down to posterity a knowledge of the costume of a period. In these details the painter had an advantage which the sculptor did not possess. The sculptor meets the painter in the grand arena; he has nothing to do with secondary art; the very materials he employs are unfit to produce a result in tinsel, colour, embroidery, or texture. He can produce at the best but weak imitation. When necessity compels him, he can carve a chain, but it has no texture or colour; he can imitate by a trick of the chisel the appearance of silk, which demands, however, that the statue have always a layer of dust in his flat effects; he may carve a piece of white lace, for there colour is co-assistant; but in all these he is limited; and the best he does is but an apology, and should never be made much of. Grand folds in drapery are his power; graceful, elegant, and beautiful arrangement, his charm. If he succeeds in that he can afford to want lace on its edges; and if he can model a noble statue *nudo*, he can afford the clothes to the ship figure-head maker. Whenever the sculptor, as he generally does, idealises the costume, by so much does he acknowledge his error in using it at all. When he clings to form, only using a few wrinkles at the knees, ankles, and elbows, he must know that he is neither serving God nor Mammon. Controlled by his employer on one side, and his own aspirations on the other, he produces a work incongruous and unsatisfactory to the very spirit of the age which coerced him.

Mr. Park then pointed out the relation between a true spirit in sculpture and an elevated style of historic painting, referring to the restoration of the Antique in the Cinquecento as the origin of that spirit which produced Michael Angelo and Raphael, and the schools of Florence and Bologna. Whenever the people had their minds familiarised with a high class of sculpture in our public monuments, the painter might prepare his colours, and cheer up his heart with the knowledge that his efforts would be appreciated, and that he would no longer be called upon to paint down to the public taste. Good sense would then be heard reasoning justly on the power of art when it became truthful.

Having argued, in defence of the *nudo*, that the Greeks or Romans did not walk about or fight naked any more than the moderns, but yet that their sculptors, with a just perception of the great in art, adopted the *nudo*, or the *nudo* with drapery, in representing them, Mr. Park contended for the application of the principle in the present day to characters of a high class, in illustration of which he referred to Thorwaldsen's statue of Poniatowsky, in which the *nudo* and drapery are admirably combined; and the statue of Napoleon by Canova, now in the possession of the Duke of Wellington. The treatment of this great statue, he remarked, has subjected Canova to much animadversion, gradually receding, however, in virulence up to the present day, when few will be found to maintain the opinions they may have been anxious to advance twenty years ago. That Canova was right, every day adds its evidence, and ignorance is gradually but surely yielding to the force of true judgment. The imitation of the cocked hat, surtout, and jack-boots, which *illustrate* the Vendome Pillar, is neither that of the man or the hero which will give satisfaction to posterity. Little models of the Parisian statue, glittering in paint, may be seen fulfilling their destiny by giving light to cigar-smokers in tobacconists' shops: never shall we see the heroic figure desecrated to so ignoble a purpose. Future ages will see Canova's work enshrined wherever intellectual power is reverenced, and artistic apprehension of the true and grand is honoured as its exponent. When the Vendome column shall be coined into sous, or re-moulded into its original cannon, the caricature of its art will only facilitate its fall; while, for its great art, Canova's statue must become a treasure to the world. Entirely *nudo* does the sculptor represent the hero, with the addition of an imperial robe hanging from his arm, and which supports the marble. In one hand is held the long rod of empire; the outstretched palm of the other holds the globe and laurel-bestowing victory. The head, modelled from the period of his great Italian campaigns, is full of that beauty immortalised in the medals of the time, and is crowned with laurel. The expression is noble and melancholy, and with it the whole frame is in unison and grace. This statue is the abstraction of the thought and power of an empire—the statue of the Vendome is that of the buffo of the guard-room.

The lecturer then gave a humourous instance of the easy manner in which a person in modern costume might be modelled as compared with the modelling of a figure *nudo* or *nudo* with drapery; and expressed his conviction that to model a man as God made him, and the same man as the tailor and shoemaker make him, requires, in point of time, twelve months for the former to one week for the latter, and in point of skill that of a man to that of a child.

Mr. Park then shortly alluded to the history of the art in Scotland, where, he said, the people hardly knew what a statue meant until about thirty years ago, when Macdonald so honourably to himself produced his heroic models in this city. His era, he characterised as the spark of the flint and steel of the workmen and educated classes in Scotland, and he saw every reason to hope that the fire he kindled was not extinct. The generality of the working classes are yet untainted by dilletantism; they have not to unlearn old prejudices, they are open to receive just impressions, and the lower classes in Scotland have ever shown a quick apprehension of the right and the true. To them principally would he appeal; to the wise and reflective of all classes would he be urgent that the bond of aspiring hopes and love of country should prompt them to leave behind those slow men or those prejudiced men, whose pride prevents improvement. In this question in a remarkable degree, there is a junction of extremes between the higher and lower classes. Both are less artificial than the middle classes. They have less thought on their minds than the money-making portion of the community, who, whatever may be the substratum of their nature, are in the majority, of necessity absorbed in commercial pursuits, and as a class are undivided in the race for wealth, and cannot spare the time necessary to study a subject like art and its relation to nature. The higher and lower classes, again, love nature; both love to look on a man and manly power; athletic exercise is common to both; beauty and grace in the poetry of Burns is felt as deeply by the peasant as the lays of the troubadours were by the knights. The man who admires the boxer out of his lumbering clothes, and can dispute points in his condition, and calculate events from his perfect or imperfect symmetry—who is accustomed to see the brawn and muscle of the stone and hammer thrower, to watch the agility of the racer or the litheness of

the vaulter, is a dangerous critic for a nude statue; and the judgment of men like these is favourable to high art, which is thus shown to be eminently fitted for the wants of a large majority of the nation. An additional reason is therefore adduced for exertion by the artists of this country to advocate by word and deed the erection of public works in sculpture of the very highest class, and the selection of pictures of a like superiority for our national galleries.

Mr. Park then referred in very pointed terms to the practice of omitting artists in the nomination of committees of taste, and the selection of individuals little qualified from their pursuits or tastes to decide in such matters. As instances of the doings of such committees, he mentioned the Nelson Monument Committee in London and the Committee for the Monument to Sir R. Peel in Manchester. It appeared, he said, that the Manchester Committee had selected a few eminent sculptors to compete, giving each fifty pounds for his unsuccessful work, the successful competitor having three thousand guineas placed at his disposal for the completion of the work, the style of costume to be that of the present day. This proceeding he characterised as at once presumptuous in the committee and unjust to art and artists. How dare the members of that committee, he would ask, virtually pronounce that there is no lurking power and talent in their own town, or in their own neighbourhood, or in the nation at large, or in the world, which an open and unlimited competition on the boasted principles of their vaunted political economy might have called forth, to honour and advance art, to adorn their city, and to illustrate the character of Sir Robert Peel. He gladly turned to the example of Salford, and bade the men of Manchester note the different estimate that committee have of their true and just position to their constituents. For the Salford Monument to Peel a competition has been announced also, but open to all the world, the site described, amount of funds advertised, and a date for the reception of designs, leaving the styles free and unfettered to the artistic skill and general knowledge of the competitors. He should not be surprised that Salford, for 1500*l*., should get a nobler work than Manchester for its 3000*l*.

After some further remarks, the lecturer concluded by calling, in eloquent terms, upon the Scottish public, to show their appreciation of the labours of the artist. He doubted not that it would be found that the late munificence of the Legislature, and the confidence of the country, would be most amply justified by the foundation of a School of Art, which, like our School of Medicine, would be known over the world. Much could be done by art for art; but amid its noble aspirations, the Scottish public must be manly and consistent in that patronage which is the aim of every artist, and the only support of a national school. If the glories of artistic triumph are to add another rose to the National Chaplet, then the nation must be as earnest in its appreciation of the labours of the artist as he will be lavish in sacrificing ease at the shrine of Scottish honour, and for the glory of Scottish Art.

MOTION OF WATER IN PIPES.

On the Motion of Water in Conduit Pipes; on Friction and Pressure in Pipes; and on Jets d'Eau. By M. D'Aubuisson de Voisins, Ingenieur en chef Directeur au Corps Royal des Mines, &c. &c. —(Translated by T. Howard, for the *Civil Engineer and Architect's Journal.*)

(*Continued from page* 165.)

Art. III.—Of the Pressure on the sides of Conduit Pipes.

Having treated of the circumstances attending the motion of water in conduits, let us examine the effects of this motion upon the pressure of the fluid against the sides of the pipes: we shall afterwards point out the most important consequences of these phenomena.

Fig. 6.

26. Let us suppose a horizontal conduit AB fitted to a reservoir kept constantly full. If we close the extremity B, each part of the pipe will experience a pressure measured by the height or head AC; and if at some points H, I, K, &c., taken indiscriminately, we insert vertical tubes, the water will rise in them until the weight of the columns HL, IM, KN, be in equilibrium with the pressure at these points; consequently it will rise in all of them to the level CD.

Let us then open the extremity B; and suppose that the sides of the pipes oppose no resistance to the motion, as in the case of a very short tube, and that there is no contraction at the entrance A. The water will flow in the conduit, and will leave it, with a velocity due to the total head AC. All the force of this head will then act parallel to the axis of the conduit; no action perpendicular to this direction will result from it, and consequently, no pressure on the sides of the pipe; as in the case of water moving in canals, where there is no pressure tending to raise its surface. The fluid in the tubes HL, IM, will sink to the level of the upper part of the water in the conduit.

27. If we only partially unclose the opening B, so that the orifice of discharge be less than the section of the pipe, the phenomena will no longer remain the same. The water will be discharged with a velocity very nearly due to AC; but the velocity in the pipe will be less, following the inverse ratio of the sections. Let v be this lesser velocity, $\cdot0155v^2$ will be the force or portion of the head AC employed to produce it: still acting on a parallel with the axis, it will exercise no pressure upon the sides. But the remaining portion of the total force, or $H - \cdot0155v^2$ (by making $AC = H$), acting on all the particles and pervading them in every direction, will press up the fluid from below at I, K, &c., and it will ascend in the vertical tubes to a height equal to $H - \cdot0155v^2$; which will be limited by the horizontal EF, CE being equal to $\cdot0155v^2$. Hence comes the great principle which Bernouilli has established by calculation, confirmed by experiment, and which he has made the basis of his Hydraulic Statistics ('Hydrodynamica,' Sectio XII.); namely: *the pressure which water running in pipes exercises upon any given point of its sides, is equal to the effective head on that point, minus the head due to the velocity in the pipe.*

28. The resistance which the sides of the pipes oppose to the motion, does not in any way weaken this principle; it only diminishes H, or the head which without it we should have had upon the point under consideration. Let us examine this in detail.

This resistance is proportional to the length of the conduit (4); that is, to the length of the journey made by the water; thus, in the same conduit it will go on progressively increasing from its origin A, where it is nothing, to its extremity B where it is $\cdot00071 \frac{LQ^2}{D^5}$ (7.) So that if on BD we take FG, equal to this expression, as representing the resistance at B; and draw the line EG, the resistances at H, I, K, &c., will be represented by the lines, ae, $a'e'$, $a''e''$, &c. (since $ae : a'e' : a''e'' : \ldots\ldots FG :: Ee : Ee' : Ee'' \ldots\ldots EF$). Let us designate these resistances by $r, r', r'', \ldots\ldots R$. At each of the points we have indicated—at I for example—the column MI, the index of the pressure in a state of repose, will sink: 1st, from Me ($= \cdot0155v^2$); for in this case as in the foregoing, this portion of the motive force, being directed in a line with the axis of the conduit, will cause no pressure on the sides. 2nd, from $a'e'$ ($= r'$); this other part of the total force having been absorbed, and as it were destroyed, by the resistance from friction between R and I, could no longer have any action on this last point: the pressure there will be measured simply by $a'I = H - r' - \cdot0155v^2$. In general, the pressure at any given point of a horizontal conduit, where r represents the resistance met with from the beginning, is expressed by $H - r - \cdot0155v^2$.

At the extremity of the conduit where the resistance is R, the pressure $GB = H - R - \cdot0155\ v^2$. If this extremity were quite open, we should have (2) $R = H - \cdot0155\ v^2$, and consequently $GB = 0$; that is to say, that the pressure of the extremity of the conduit would be nil, and that the columns increasing the pressure at its various points will have the line EB for their highest limit.

29. Let us consider finally the case of an ordinary conduit, that is, of a conduit inclined and having the extremity only partially open. In a state of repose, the columns indicating the pressure will be raised to the horizontal CD, the level of the fluid in the reservoir, according to the Hydrostatical law of *Communicating Tubes:* they, and consequently the pressures, will be unequal; each will have for measure the difference of level between the point where it is exercised and the surface of the reservoir. When the fluid is in a state of motion, these columns will undergo the same

diminutions as in the preceding number, and by reason of the same causes; their summits will only reach the line EG, which will be their limit (they would be limited by EB, if the conduit were quite open); consequently, the pressure upon any one point of which H_0 is the depression below the reservoir, will be expressed by $H_0 - r - \cdot 0155\, v^2$.

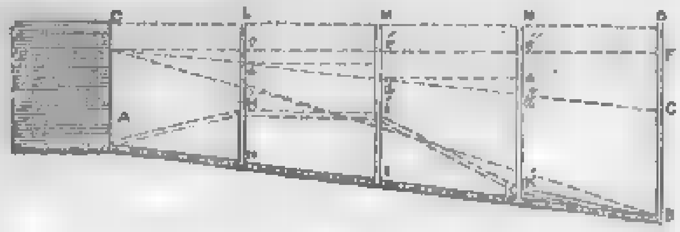


Fig. 6.

The expression will be the same for an undulating conduit as AH′ I′ K′ B; only the summits of the columns will no longer be in a right line; the resistances, being proportional to the length of the pipes, will strictly follow the ratios of AH′, AI′; but not those of E a, E a'; a condition necessary in order that the points A, a, a', may be in a right line.

Total Head; and Effective Head.

30. We have called the *head of a conduit*, and designated by H, the difference of level between the surface of the fluid in the reservoir, and the orifice of discharge; it would be the height due to the velocity of discharge, if the pipes offered no resistance to the motion. But the resistance diminishes this *entire head*, so that the *effective head* of the conduit, or the height by virtue of which in reality the fluid runs out, will be less according to the resistance which it will have met with, from the beginning to the extreme end of the pipes; R being that resistance, the effective head will be $H - R$.

By analogy, for every point of the conduit, its *total head* will be the height of the reservoir H_0 above it; and its *effective head* will be this same height diminished by the resistance experienced by fluid from the origin of the conduit to it, or $H_0 - r$.

Difference between the Head and the Pressure.

31. Since the pressure upon this same point is $H_0 - r - \cdot 0155\, v^2$, $\cdot 0155 v^2$ will be the difference between it and the head. In general, the height due to the velocity of the water at any point of a conduit, is the difference which exists there between the effective head, or the head properly so called, and the pressure upon this point. It is not correct to take one for the other; but in large conduits, where the height due to the velocity is very small, the error is seldom or never of consequence.

Of the Piézomètre and its Indications.

32. The guage tubes which we have supposed to be placed on the conduits, (and which, by the height to which the fluid is raised in them, measure the pressure which exists at the points to which they are fitted,) have been named in France, Piézomètres (*piesis*, *piesos*, pressure; and *metron*, a measure).

They serve to give us as it were a physical representation of what is understood by *resistance* and loss of head. Let us suppose that we have fitted one upon a given point of a conduit situated at H_0 below the level of the reservoir. According to what has just been said, if the water were in repose in the conduit, it would rise in the tube to the height H_0; when the water is running it will sink, and remain at the height $H_0 - r - h$, h being the elevation due to the velocity v. The depression, or the difference between the two heights will be then, $H_0 - H_0 + r + h$; and in designating it by x, we shall have $x = r + h$; or, $r = x - h$; that is to say, *the resistance experienced by the water, from the origin of the conduit, to any point of its length, will be represented by the difference of level between the surface of the reservoir and the summit of the fluid column in a piezometer fitted upon this point (minus the height due to the velocity in the conduit*, a quantity always very small). If we augment or diminish the volume of water running in the conduit, and consequently its velocity, by enlarging or contracting the orifice of discharge, the fluid in the piezometer will become lower or higher, in a slight degree, very nearly proportional to the square of this volume or velocity.

$$\left\{ \text{The depression ought to be } Q^2 \left(\cdot 00068 \frac{L}{D^5} - \frac{\cdot 02512}{d^4} \right) + Q \frac{\cdot 000095 L}{D^3} \right\}$$

and we shall have to compare the results of theory with those of experiment.

For a second point of the conduit, taken, for example, lower down stream than the first, we should have in like manner $r' = x' - h$, since the velocity of the height due to it, h, remain the same throughout the conduit. Cutting off from this equation the first $r = x - h$, we have $r' - r = x' - x$. Now, $r' - r$, the difference between the two resistances, is evidently the resistance met with from the first point to the second; and $x' - x$, the difference between the depression of the two piezometrical columns below the reservoir, will be the difference of level between the summits of the two columns; thus, *the resistance which the water meets with from one point of a conduit to another, or the loss of head from the first to the second, is indicated by the difference of level between the summits of the fluid columns of two piezometers, fixed one on each of the two points.* If the diameter of the pipe on which the second piezometer is fixed were different to the first, then the height h' due to its velocity would no longer be equal to h, and we should have—

$$r' - r = x' - h' - (x - h) = (x' - x) - (h' - h);$$

that is, the resistance from one point to another would be measured by the difference of level between the two piezometrical summits, minus or plus the difference between the two heights due to the respective velocities, according as the velocity at the point down stream should be greater or less than the other.

We see, by these examples, how the piezometer renders perfectly clear the resistance in pipes, and the variations which take place in them; and, consequently, how useful its indications may be. I have such an instrument, made of glass, fixed on one of the conduits of Toulouse, and carried into the office of the engineer of these works; and it indicates to him constantly the state of the water, and the disturbances it meets with.

Thickness required for Conduit Pipes.

33. [Under this head, D'Aubuisson discusses the theory of the force of pressure tending to burst a conduit pipe; and then from the results of experiment on the cohesive strength of cast-iron, deduces the thickness of pipe necessary for various diameters to withstand this pressure. Adding to this theoretical value, a margin to allow for the sudden shocks to which conduit pipes are liable, and for the imperfections usual in castings, the formulæ which he finally submits and has adopted for practice is, calling thickness of pipe e,

$$e \text{ in inches} = \cdot 394 \text{ in.} + \cdot 015 \text{ dia. in inches.}$$

For pipes of less than $4\frac{1}{2}$ inches diameter, he considers there is no necessity to add the second term of the equation, but makes them all about $\frac{3}{8}$-inch in thickness.

This formulæ is for pipes proved to ten atmospheres, or about 300 feet head.]

Art. IV.—Of Systems of Conduits.

It is rare in practice that we have to deal with a simple conduit, conveying to its extreme end all the water it receives at its origin. A portion of this is generally carried off, at various points, by secondary conduits; from these again branch pipes of a third order, so that a large distribution of water in a city or town, presents as it were a trunk branched and sub-branched in every direction.

34. To determine the circumstances of the motion of water in the different parts of such a system, and that by the knowledge alone of the dimensions and respective position of the several parts, is a complicated problem, of which a solution has not yet been given; and yet the calculations which an engineer has to make relate generally to a system, and not to an isolated conduit.

To form an idea of the basis on which I have established the solution that I am about to give, and which is applicable to at least some cases, let us suppose a system already existing, adapted to a reservoir maintained constantly full, and discharging water through mouths at the end of various branches. Let the question to be determined be, for instance, the quantity of water flowing out of each mouth (although that is not the object we have now in view), it is evident that we could immediately calculate this quantity if we know the *effective* head of water at the end of the branch, that head of water being the height due to the velocity of discharge (30). But after what has been said (30—32) the effective head is the entire head, minus the loss of head or resistance that the fluid has experienced in its passage through the system from the reservoir to this mouth; so that this problem is reduced to the determination of the amount of the several losses of head.

Of the Several Losses of Head.

35. These arise, 1st, and almost solely, from the frictional resistance of the sides of the pipe. 2ndly. From the resistance due to the bends. 3rdly. From the change of direction in the movement

when the water passes from the main conduit into a branch, and from a branch into a sub-branch. 4thly. From eddies occasioned by the diversion of the water at the head of each branch or sub-branch. As to the resistance arising from contraction, it is unnecessary to take it into account; we should not admit a permanent contraction in a conduit: if one accidentally exists we have pointed out the method of calculating its effect (20.) We have seen (15) that all resistance to the motion of water in a conduit pipe is an effort opposed to the motive force or total head, and which absorbing a part of it, causes a loss of head.

We have treated in detail the first two of the four losses that have just been pointed out, and shall now limit ourselves to the recapitulation of them.—The equation for the resistance of the sides (6) is

$$= \cdot000677\text{L}\left(\frac{\text{Q}^2}{\text{D}^5} + \frac{\cdot1417\text{Q}}{\text{D}^4}\right).$$

For the resistance from bends (17)

$$= \cdot00808\,\frac{\text{Q}^2}{\text{D}^4}\,\sin^2;$$

The other two remain to be examined.

Loss of Head arising from Changes of Direction.

36. When a body moving with a velocity v in one direction, is forcibly turned in another, making an angle i with the first, its velocity is then only $v \cos i$. In the same way, when a fluid in a conduit having a velocity v, passes into a branch, obstructing the other forces which may act upon it, it will then only have the velocity $v \cos i$. The force or head due, which was $\cdot0155\,v^2$ in the conduit, will only be $\cdot0155\,v^2 \cos^2 i$; it will then have lost in head $\cdot0155\,v^2\,(1-\cos^2 i)$, or $\cdot0155\,v^2 \sin^2 i$.

Almost all branches are made at right angles to the main conduit, although they afterwards be diverted by greater or less bends. In this case $i = 90°$, $\sin i = 1$, and the loss of head, recollecting that $v = 1\cdot273\,\frac{\text{Q}}{\text{D}^2}$, is $\cdot0252\,\frac{\text{Q}^2}{\text{D}^4}$; that is to say, the head or force due to the velocity that the water has in the main conduit is entirely lost: it has no effect in the direction of the branch: the fluid only enters this by virtue of the pressure (or piézométric height) existing in the conduit at the point of junction.

Loss due to Erogation.

37. At this junction there will be yet another loss of head. In order to measure its amount MM. Mallet and Yénieys, engineers of the Paris Water Works, placed a piézomètre on a conduit 9½ in. diameter, a little above the junction of a branch of 3¼ in. diameter; and they placed a second guage a little way down this branch. The water stood in this last ·39 feet lower than in the first, the quantity discharged through the branch being ·1535 cubic feet per second; the velocity was 2·778 feet, and the head due to that velocity ·120 feet: this last quantity should be taken above the elevation of the first piézomètre to impart the above mentioned velocity, there will then remain only as the difference, or for the effect of erogation, ·274 feet, a quantity 2·28 times greater than that due to the height. The discharge from the branch being increased to 35·4 cubic feet, the difference between the two piézomètres was ·502 feet; the height due to the velocity being then ·168 feet; and there remained for erogation a quantity 1·94 times greater than that height. We conclude from these experiments that the loss of head occasioned by erogation is equal to about twice the height due to the velocity in the branch.

Any uncertainty as to the amount of the loss of head due to erogation, as well as those arising from bends and change of direction, does not involve any practical consequence, these values being so slight relatively to the others which enter into the equations, especially to the loss resulting from the action of the sides, and the latter has been determined by the aid of more than fifty experiments.

38. For some time I feared that the erogations for the branches might extend their effect to the conduit itself, below the points of junction, and that the head might experience a considerable diminution. If it had been so, the solution of the problem which I give here, and which I had implicitly given in my '*Traité sur le mouvement de l'eau dans les Conduites*, 1827,' would have been completely defective. To decide this important question, I instituted the following experiments in 1830:—

On a conduit 3¼ inch diameter, 2090 feet long, I had placed at 1414 feet from its commencement, a tube having a cock through which we could let off a greater or less quantity of water; this represented the circumstances of a junction. At 1·61 feet above, as well as at 2·30 feet below, we fixed a large piézomètre; the head of water on the conduit remained nearly constant,) 24·28 feet, and its extremity was quite open. We discharged through the junction the volumes of water indicated in the margin, and have noted opposite those which flowed from the extremity, as well as the height at which the water stood in each of the two piézomètres. As we could not determine the heights within about ½ of an inch, we may conclude they were the same above and below the point of junction. This equality of pressure was maintained in several other experiments that I made with the same apparatus.

Water discharged in One Second.		Piézomètre.	
At the Junction.	At the end of the Conduit.	Above.	Below.
Cubic feet.	Cubic feet.	Feet.	Feet.
·000000	·059860	6·23	6·27
·009479	·052656	4·99	4·99
·029494	·036058	2·98	3·05
·045250	·020448	0·59	0·56
·048736	·018152	0·39	0·33

Thus a branch made in a conduit does not sensibly diminish the pressure or head below the point of junction; and in a system of conduits, we may consider that there are no other losses of head but the four in question.

Final Equation for the Motion in a Branch.

39. Let n be a branch or sub-branch of any order whatever, supposed to be quite open at the end. Again, let

- d_n be the diameter of such aperture at the end.
- m_n the coefficient for contraction.
- H_n the entire head of the branch, or the difference of level between surface of the reservoir and the orifice of discharge.
- D_n the diameter of the branch.
- L_n its length.
- Q_n the quantity of water it conveys.
- S^2_n the sum of the squares of the sines of the angles of reflection at the various bends.
- [R] the sum of the resistances or losses of head experienced by the water which flows in the branch down to its junction.

If, by following the course of the water which reaches it, we represent by r and r' the losses of head due to friction and bends upon the main conduit as far as the first branch; by r_1, r'_1, r''_1, r'''_1, the four losses of head upon this first branch; by r_2, r'_2, r''_2, r'''_2, the four losses of head upon the second up to the third branch; and so on successively up to the branch $n-1$, to which is adapted the branch n, we shall have—

$$[\text{R}] = r + r' + r_1 + r'_1 + r''_1 + r'''_1 + \ldots\ldots r_{n-1} + r'_{n-1} + r''_{n-1} + r'''_{n-1},$$

since the sum of the losses of head, deducted from the total head, gives the head due to the velocity of discharge (34); or, rather, the entire head is equal to the sum of the losses plus the head due to the velocity of discharge, which is (13) $\cdot0252\,\frac{\text{Q}^2_n}{m^2_n\,d^4_n}$, and the equation will be

$$\text{H}_n = [\text{R}] + \cdot0252\,\frac{\text{Q}^2_{n-1}}{\text{D}^4_{n-1}} + \cdot000677\text{L}\left(\frac{\text{Q}^2_n}{\text{D}^5_n} + \frac{\cdot1417\,\text{Q}_n}{\text{D}^4_n}\right) +$$

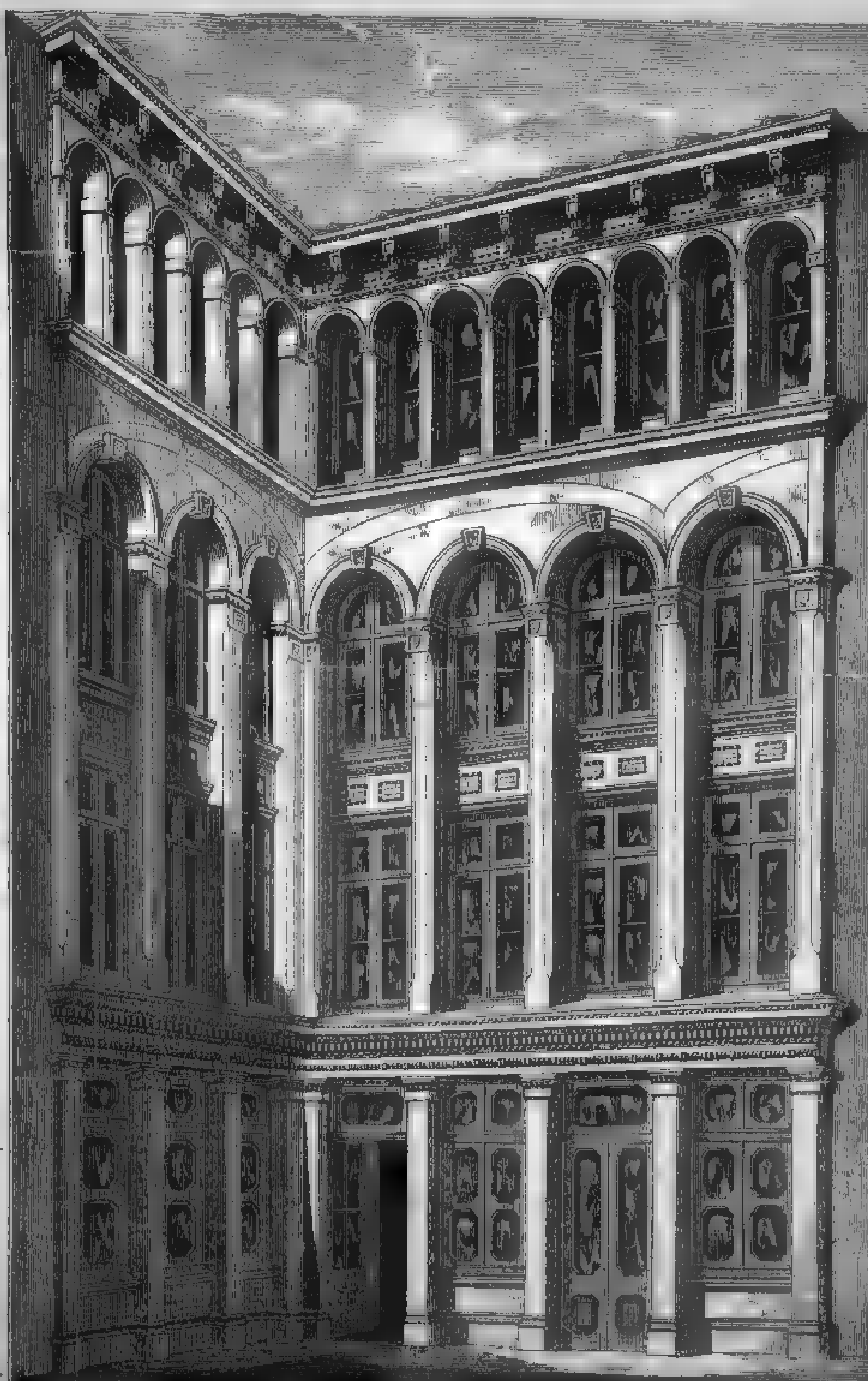
$$\cdot0061\,\frac{\text{Q}^2_n}{\text{D}^4_n}\cdot\int_n^2 + \cdot165\,\frac{\text{Q}^2_n}{\text{D}^4_n} + \cdot0252\,\frac{\text{Q}^2_n}{m^2_n\,d^4_n}.$$

When the branch is entirely open at its extremity, $m^2_n\,d^4_n = \text{D}^4_n$.

The above equation enables us to determine, directly or indirectly, either of the values implied in it, from a knowledge of the others.

ADELAIDE CHAMBERS, GRACECHURCH STREET.

The engraving we now give represents some chambers and buildings around what many would make into a common alley. Mr. Charles Corbett, architect of this design, has, however, without any ambitious attempt to carry out a costly structure, created a picturesque composition, of which there are few examples of the same kind in the City. The shape of the ground and opening seemed unfavourable to any harmony of design; but as now arranged, and by the treatment of the walls, a very pleasing effect is produced. We think this endeavour very praiseworthy; and though we may differ as to details, we think the example well worthy of being adopted in many situations in the City, where the only unity is the correspondence of square windows, and the only simplicity that of brick walls.



ARCHITECTURAL REMAINS OF THE ROMAN PROVINCES.

On the Architectural Remains of the Roman Provinces. By JAMES BELL, Esq.—(Paper read at the Opening Meeting of the Session 1850-51 of the Royal Institute of British Architects.)

ALTHOUGH the architectural remains of Rome and Italy in general have been thoroughly investigated, there is reason to reflect that other parts of the extensive empire of the Mistress of the World have not received the attention they deserve; and that while there is no doubt that a perfect and correct taste is only to be acquired by a study of the best works, it should not be forgotten that many remains of inferior artistic merit may yet present varieties of form and idea deserving of attentive consideration. The more complete our knowledge is of the whole scope of ancient art, the more likely are we to be correct in attempting to realise a just conception of the original nature of the best works, many of which are now in so hopeless a state of ruin. The student, therefore, might do well to add to his examination of the remains of the Eternal City itself, that of some of the Roman provincial towns, which the want perhaps of a correct appreciation of the character of that people has hitherto caused to be, in great part, neglected.

Nothing marks more strongly this character in the later ages of the Republic and during the rise of the Empire, than the method pursued by them in dealing with surrounding nations. They had no desire for allies and tributaries; their treaties were hollow and treacherous, intended to be broken on the first opportunity, conquest being their only aim,—not with the view of obtaining subjects, but in order that each nation should in turn be incorporated with Rome, and form an integral part of the great empire. For this reason, submission was quickly rewarded with freedom and every Roman privilege, while resistance was punished to the last extremity. We should therefore naturally conclude, that evidence would be found in the monumental records of the provinces of Rome, of this identity with the mother country—and this we find to be the case. Germany, France, Spain, Africa, Egypt, and Palestine, all contain specimens of greater or less magnificence and grandeur, many in a high state of preservation, and some possessing peculiarities of form, construction, and arrangement, which render them highly interesting and valuable. I shall endeavour to call attention to some of the most important of those monuments, and to show that correctly measured representations of them deserve a place on our shelves, by the side of the illustrated works by Stuart and Revett, and by Taylor and Cresy.

Omitting all allusion at the present time to the underground remains which abound in this country and elsewhere, as well as to the roads and fortresses, which belong rather to engineering than architecture, we need not go far to find some monuments of considerable importance. The Porta Nigra at Treves is a stupendous work—two towers, 90 German feet in height, and more than 30 feet in diameter, and decorated with four orders of columns, are united by a curtain, 55 feet in extent, and three stories high, in which are the two gates; excepting the lower story, the whole is also arcaded. This design of a gateway is unique, and it exceeds in dimensions any similar building elsewhere. Treves possesses also the remains of an amphitheatre, in which some peculiarities of the substructure are apparent,—also those of a basilica; but next to the gate, the monument of Igel is the most curious, and may be compared with one of a similar description at St. Remi in the south of France. There was also a monument of a similar description at Arlon, but the ornaments were transported in the 16th century by the Count de Mansfeldt, to form part of a collection of antiquities long since dispersed: that of Igel was happily preserved from the same fate. Had these monuments attracted the attention they deserve, some better idea could now be given than a mere verbal description. It was one inevitable consequence of the Roman policy before described, that all remains of a former civilisation were inevitably obliterated, but there are strong reasons for supposing that this neighbourhood was very far from being in a state of barbarism before the Roman conquest. We may believe this without going back to the early foundation of Treves claimed by some historians.

But it is in the south of France that we can more completely form a correct idea of a Roman province. This portion of France formed the province of Gallia Narbonensis, having been subdued from one to two centuries before the Christian era. Here the arches, gates, temples, amphitheatres, and aqueducts, rival those of Rome itself, which possesses no temple of the kind so perfect as the Maison Carrée, at Nismes. This edifice is a hexastyle prostyle temple of the Corinthian order, and originally stood in the centre of a forum, the extent of which has been traced by the bases of several of the columns found *in situ*. The Temple of Diana, as it is called, but which was in reality the Hall of the Baths, exhibits a beautiful arrangement of pilasters and niches in the interior, connected with a shrine in the centre of one end, of great elegance and originality. The amphitheatre, though smaller than the Coliseum, is in a far better state of preservation. This was built at the expense of Antoninus Pius, whose ancestors came originally from Nismes, and the Maison Carrée was dedicated to his adopted sons, Lucius and Marcus. It will be seen from the plan of the amphitheatre, that it is constructed somewhat differently from the Coliseum. We can here study the preparations for the velarium; the arrangements of the seats, galleries, and staircases. The podium round the interior is formed of single stones, 5 feet in height, to retain the water for the purposes of the naumachia.

The antiquities of Arles consist of an amphitheatre, a theatre with two columns of the proscenium still standing; and innumerable tombs and sarcophagi. Orange possesses a theatre of the most gigantic dimensions; the seats are cut out of the side of a hill, and the scene wall rises to a height of more than 100 feet by 300 feet in length. Though the marble decorations are, as in many other instances, almost entirely gone, it is still a most interesting relique. There are also several arches remaining of the hippodrome, and a beautiful triumphal arch in a very fair state of preservation. The ornaments have suffered from the singular purpose to which the building was appropriated by the Princes of Orange—when it was built into the Chateau, and the archway formed the principal *salle de reception*. The portion of the Roman aqueduct, now called the Pont du Gard, is too well known to require a detailed description.

The monopteral monument at St. Remi is of most beautiful design and proportions, and well deserves study as a model of this description of edifice. The gates of Nismes, Besançon, Sens, and Saintes, between La Rochelle and Bordeaux; the amphitheatre, aqueduct, and the Porte Dorée at Frejus, the birth-place of Agricola; the arches at St. Remi and Carpentras; the bridge and arches at St. Chamas, between Arles and Marseilles; and the innumerable fragments collected in the museums of Nismes, Arles, Avignon, Narbonne, and Toulouse, offer to the student who wishes to become acquainted with Roman art in the time of the Antonines, the strongest temptations to be found within the range of a summer excursion.

Spain offers an example no less striking of the peculiar character and vicissitudes of a Roman province. All vestiges of early civilisation previous to its subjugation are gone, and in its place we find most extensive remains of Roman enterprise and constructive skill, of which it is much to be desired that we possessed more detailed and illustrated descriptions than those which are at present within our reach. We learn, however, from the hand-book, that there is a Roman bridge at Merida, 2575 feet long, besides numerous antiquities, among which is a peripteral temple. At Alcantara is a bridge of Trajan, 600 feet long, and 245 feet above the usual level of the river. At La Barca five arches remain of a Roman bridge; the same at Capara; at Toledo there is a temple; near Tarragona a superb aqueduct, and a monument called the tomb of the Scipios, and at Segovia an aqueduct, 2500 feet long.

Passing now to Africa, we find that the same destruction of previous evidences of civilisation took place here as in other colonies. All that remains of Punic Carthage are a few inscriptions occasionally dug up: everything else is Roman. The best illustrations we have of these ruins are contained in two volumes of drawings by Bruce the African traveller, which are now in the royal collection at Windsor. Besides the usual amount of triumphal arches, some of which are of forms not elsewhere met with, there are other buildings of an unusual description. Of the first class is one large square inclosure at Suffetala, entered by a large triumphal arch, and containing three Corinthian tetrastyle temples connected together. At Lambesa a building, something in the form of a basilica, now roofless, entered on each of the four sides by a large centre arch, with two small ones flanking it; two orders of engaged columns, with broken entablatures, forming the exterior decoration. At Thisdrus, a very fine amphitheatre, approaching the Coliseum in size, and even surpassing it in state of preservation. At Tripoli, an arch of the time of the Antonines. Considering the Cyrenaica as a Greek colony rather than a Roman province, we may omit a detailed description of the remains, which, we are informed by Captain Beechey, consist of sculpture of the best style,

with tombs, pavements, theatres, amphitheatres, and city walls, very perfect. Greece and her colonies, as well as Egypt, formed some exceptions to the usual routine of Roman conquest—Grecian civilisation acquired the respect even of the imperious Roman, and severity was only exercised towards the Grecian race, when provoked by imprudent resistance. Egypt also wisely submitted—Ptolemy bequeathed his kingdom as a legacy to the Roman republic, but the Egyptians kept aloof as much as possible from Rome; and while they avoided disputes, they equally renounced a participation in the honours of a close connection with the people who had overthrown the empire of the Pharoahs, and it is not till the third century of our era, that we find natives of Egypt accepting office under the empire. We may thus account for finding remains of Grecian civilisation in Cyrene, and of Egyptian architecture in Egypt; while all vestiges of Punic civilisation are lost, both on the African continent and in the Spanish peninsula.

Turning our attention next to Egypt, we find in the remains of Antinoë very curious and interesting examples of Roman art. At Alexandria many fragments are constantly being brought to light, and used in works now in progress; and Pompey's pillar has been made familiar to us, both by pen and pencil. Abd-al-Latif, an Arabian physician of the time of Saladin, says, in his description of Egypt, that he had himself seen on the coast more than four hundred columns broken in two or three pieces, of which the material was the same as this column, and which appear to have been from one-fourth to one-third the size. He adds that he could see by the fragments, that they had originally been covered with a roof. The translator states that this explains the origin of the Arabic name for the column—Amoud Alsawari, or the pillar of the colonnade; proving that it was originally placed in the centre of a forum, in the manner of that of Trajan at Rome. Denon gives a sketch of a column at the ancient Oxyrinchus, which appears of a colossal proportion, and with the remains of the architrave still existing on the capital; but the chapter in which we are led to expect the description gives us no dimensions.

The remains of Petra in Idumæa have been familiarised to us by the labours of Roberts and Laborde; but apart from their value as examples of a peculiar style, it is a subject of much interest to have a satisfactory elucidation of their date and of their history, in obtaining which careful search for inscriptions on the spot might no doubt materially assist. It is to Palestine, however, that we must look for a rich harvest of Roman architecture, in a field as yet almost untrodden by architects. Baalbec and Palmyra, the most important of its cities, have been to a certain extent investigated; but Palestine abounds with other Roman remains, which have been hardly sketched, much less measured and correctly delineated. At Antioch we find triumphal arches. At Misseron, the remains of a small but beautiful hexastyle Doric temple, the interior decorated with four Corinthian columns. At Ezra, the ancient Zarava, the ruins occupy a space of three or four miles in circumference; among others a large quadrangular edifice with thirteen rows of arches, five in each row; and in every part of the town Greek inscriptions. At Amyouan, between Beyrout and Tripoli, is a tetrastyle Ionic temple, adorned with rich sculptures. Gerash appears to be one of the cities most fertile in architectural remains in this district, next to Baalbec and Palmyra. Among other objects is a temple near the gate, and facing it a large semicircular colonnade of the Ionic order, most of which, with the entablature, is still standing; the centre of this, exactly opposite the portico of the temple, opens upon the principal street of the city, also flanked by colonnades, and above a mile in length. There is also a large peripteral temple of the Corinthian order, surrounded by a double colonnade of smaller columns, in the manner of the temple of Venus at Rome.

At Damascus there is a fragment which has been already brought before the notice of the Institute. There are many others of which professional descriptions are wanting. The history of Baalbec and Palmyra is involved in much obscurity; and yet, architecturally speaking, these cities, with Petra, are among the most wonderful and interesting in the world. Petra for its extraordinary situation and character; Baalbec for the beauty of its style, and Palmyra for the unequalled extent of its remains.

In Asia Minor, notwithstanding the labours of recent travellers, what remains to be done in the investigation of ancient remains far exceeds what has been already accomplished. Some notice of the remains of Termessus have been already brought before the Institute; but in Caramania there exist some valuable remains of other cities; among others, those of Side. The walls are in some places perfect, and offer a curious example of ancient fortification, besides the usual accompaniments of an ancient city. There are some interesting antiquities at Cacamo. A bath with piers supporting a vaulted roof of considerable space; and a granary built by Adrian or Trajan. It appears to have been customary to erect public granaries along the lines of the main roads for the supply of the troops on their march.

It is needless to dwell on the Roman works at Constantinople—the aqueducts and cisterns have been often sketched but never measured. In Romania and other parts of the North of Turkey in Europe, as well as in Dalmatia and Istria, and wherever the Roman sway extended, monuments of more or less interest are to be found, the number of which might no doubt be increased by further investigation and research.

Remarks.—The Chairman observed, that Mr. Bell had opened a wide and interesting field, and many present had no doubt traversed some of the ground he had been over, and might be able to add some further interest to his remarks. It occurred to him (Mr. Fowler) to mention as an instance, that the road near Caudebec, in Normandy, passes through the remains of a Roman theatre or amphitheatre, having circular arcades. He had not seen any notice of these remains.

Mr. Tite, Fellow—explained that they are situated at Lillebonne, anciently Juliobona, and are intersected by the old road from Havre to Rouen. There is in the same town a remarkably fine church of the Decorated period, of which he could not find a view or plan in any of the illustrated works on France. The members were much indebted to Mr. Bell for the pains and research exhibited in the paper just read. Mr. Tite had no doubt that much might be learnt of ancient art, *out* of Rome; but at the present day, we learn nothing of Roman architecture, either in Rome or out of it. Nothing but mediæval architecture seems now to be the fashion, a circumstance which must be a matter of regret to all who have studied in earlier days a style which he considered infinitely better adapted to modern times and purposes. He would venture to say how necessary and essential he held it to be, that a young architect should study the remains of Greece and Rome. Mediæval art would no doubt afford useful principles of design and construction, but he could not conceive that a good architect could regard his studies as complete, without a distinct investigation of the principles of Greek and Roman art. We are too forgetful of those principles in the present day, and therefore he the more valued the efforts made by the author of the paper just read; particularly as showing how much may be learnt in connection with Roman architecture out of Rome itself. With regard to Roman architecture in Spain, a work written in Spanish, by Pons, may be considered to contain an excellent account of the Roman remains in that country. It was printed in eight or nine small duodecimo volumes, about the and of the last century. Mr. Tite then moved a vote of thanks to Mr. Bell.

Mr. Donaldson, Hon. Sec. For. Corr., observed, in reference to the introductory part of Mr. Bell's paper, that we should not suppose that the Romans were employed solely in conquest, and not in diffusing a knowledge of the arts, because it must be well known that a great civilising spirit existed in them, and that wherever their conquests extended, they endeavoured to introduce good forms of government and municipal institutions. They expended large sums in the erection of monumental edifices in their provinces, even in England itself; and it must be a matter of regret that we have not a work worthy of being cited as 'Anglia Romana,' possessing as we do, a great number of buildings worthy to be recorded. If we had such a work, well illustrated, in the style which our works on mediæval art display, we should bring to light a number of interesting facts. Indeed, it ought to be a national work, promoted by the government. With respect to the monuments at Petra, he thought, from looking at the engravings that have appeared, that they present no evidence of Greek art at all, and that they must have been erected during the Roman dominion, in the time perhaps of the Antonines. With respect to the cities on the coasts of Asia Minor, reference may be made to the letters of Pliny, which recite the great number of buildings erected there under the Roman empire. It had occurred to him that all the buildings erected by the Romans out of Italy, are of a much lower class of art than those in Italy itself, and they are apparently of a later period, and have not the refinement of the Italian specimens.

Mr. Scoles, Hon. Sec., mentioned that it had been ascertained that the column of Pompey at Alexandria, had been originally an obelisk, which the Romans had rounded and converted into a column; this became apparent on making some excavations underneath, when the hieroglyphics were discovered.

Mr. Tite, Fellow, said that Mr. Barry had made during his

travels a correct plan and a collection of sketches of the most accurate kind, of the ruins of Gerash and other neighbouring cities, which he had closely investigated.

Mr. G. Godwin, Fellow, called attention to the excavations in progress at the Roman castrum, at Lymne in Kent, where, for want of funds, a Pompeii close at home is entombed, which might be opened for the satisfaction and instruction of all England

Mr. C. H. Smith, Visitor, expressed his doubts as to the accuracy of the details and ornament given in the large works, under the names of Dawkins and Wood, though the measurements might possibly be correct. He had seen the original sketches some years ago, and observed that many of them were very slight, and that the drawings taken from them for the engraver, were made up in the style of ornament then in vogue, rather than in the spirit of the originals.

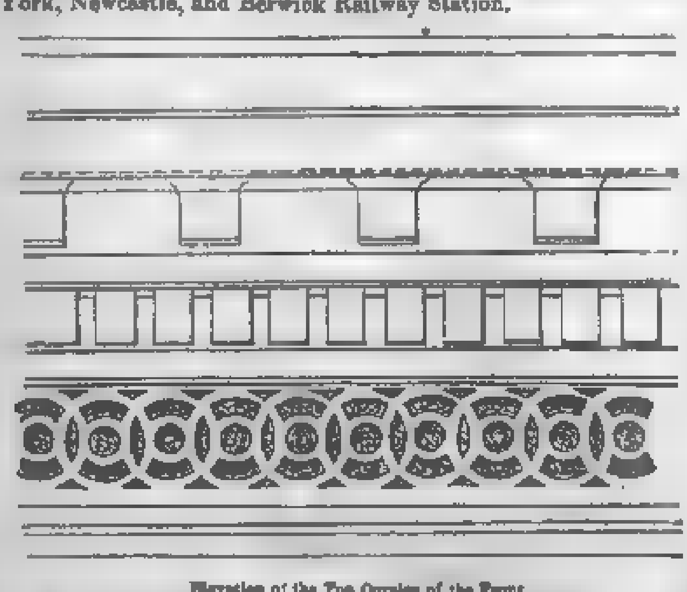
Mr. Scoles, Hon. Sec., observed, when he was at Baalbec he had not that work with him, but his impression of the originals was, that they were equal, if not superior, to the finest specimens he had seen in Rome; the ornaments were elaborately and finely executed, and the Corinthian porticoes in his opinion where the finest in the world.

The Chairman, in announcing the vote of thanks, expressed his regret that Mr. Bell had not divided his ample and interesting subject into two papers, instead of condensing it, in order to bring it within the scope of one evening's proceedings. He then made some remarks in allusion to the Palace of Diocletian at Spalatro, which, judging from the remains as illustrated in the work published by Adam, had evidently been erected after the decline of art in the Roman Empire, and which, though designated as a palace, was in point of fact, intended for a fortress.

NATIONAL PROVINCIAL BANK OF ENGLAND, DARLINGTON.

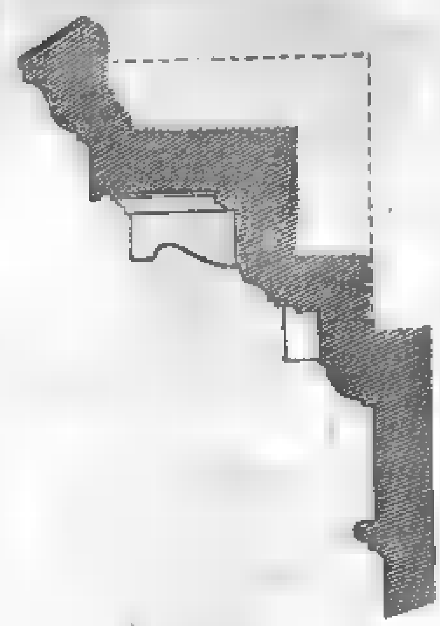
Those who look back to the last century will find, that whatever opportunities it afforded the architect for great monuments, it was far from yielding the same scope in street architecture as now. Churches, chapels, and mansions there were then, as now; but we are much better off with the banks, clubs, assurance offices, colleges and schools, not to speak of county courts, and many more classes of public buildings.

The subject we now give is not one of the more ambitious of its class, but is a very good example of the application of moderate resources. It is the building occupied by the Branch of that large company, the National Provincial Bank of England, in the respectable town of Darlington, and in which there are now two joint-stock banks. It is situated on the High Row, in a very conspicuous part of the town, facing the principal approach from the York, Newcastle, and Berwick Railway Station.



Elevation of the Top Cornice of the Front.

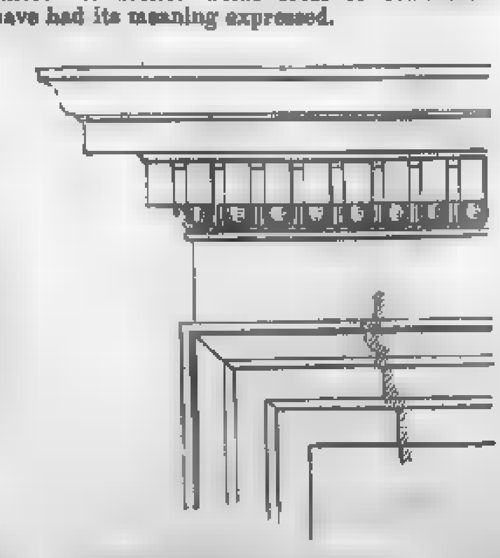
The design for this structure was entrusted to Mr. J. Middleton, an architect practising in Darlington; and we are happy to have the opportunity of giving this proof of his successful application. The site is, it will be seen, narrow, and the means at Mr. Middleton's disposal small; but by careful disposition and study, he has produced a building which, without pretension, is effective, and which it is none the less pleasing is completed within the estimate. We are very fond of columns when properly applied, but we are much better pleased in a composition of this kind to see that their employment is not attempted. It too often happens that stereotyped columns and pilasters are stuck on, by their ostentation to hide the architect's poverty of labour and resource; whereas, when such adventitious aid is rejected, there is always the hope of careful treatment. This, we consider, has been the result in Mr. Middleton's case, as the Elevation will show, and the details of some of which we have given engravings.



Section of the Top Cornice of the Front.

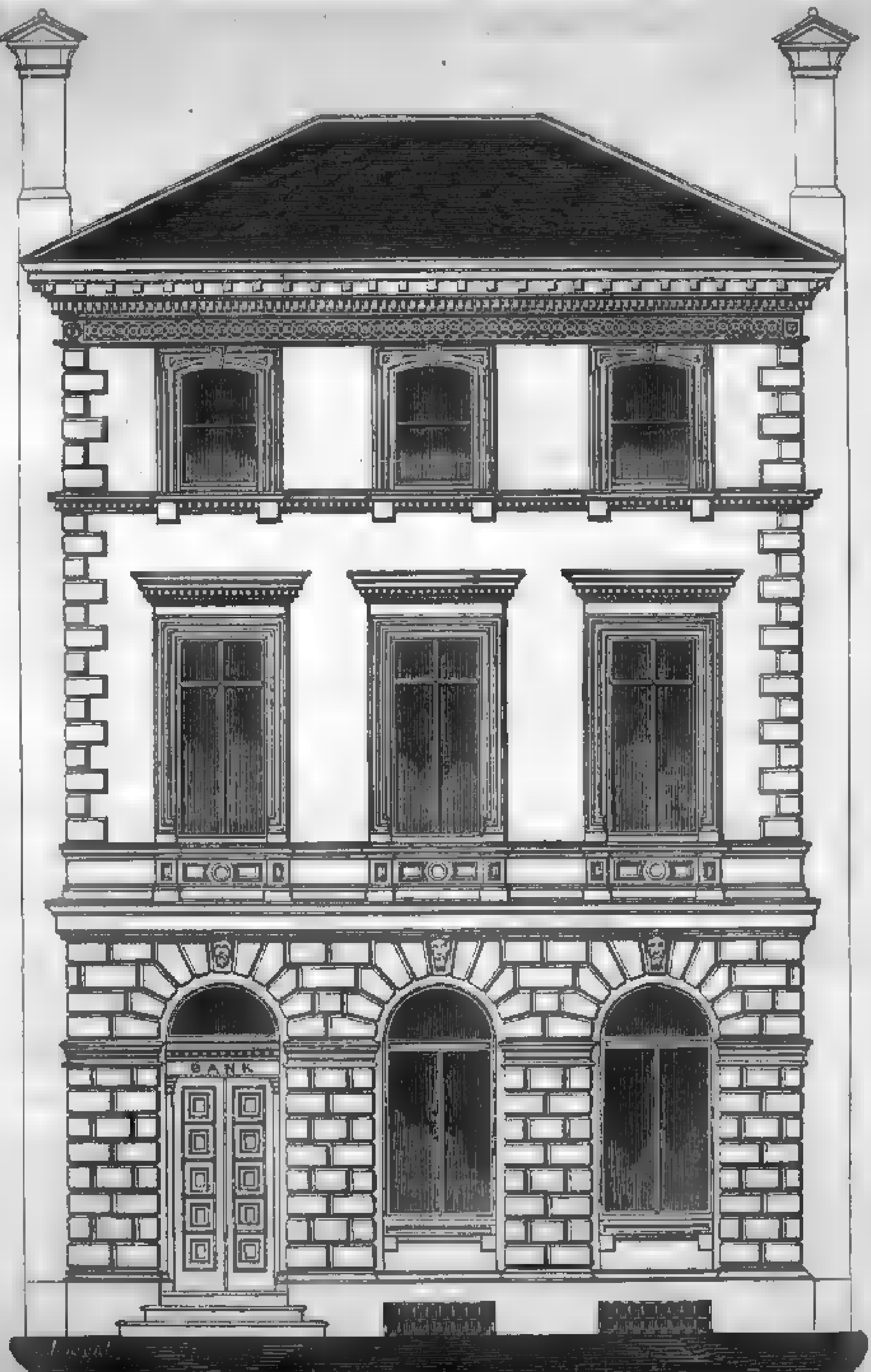
The management of the ground-floor is very good, and by attending to the breakings of the joints, the line of composition is carried up to the first-floor windows.

The treatment of the cornice, without being expensive, is rich; and the boldness of the proportion affords shadow and relief. The finish of the middle range of windows is likewise in good keeping. Whether the masques on the ground-floor keystones might not have been supplanted by emblems more significative, we leave to the architect to settle. Some local or commercial association might have had its meaning expressed.



Section and Elevation of Cornice to the First-floor Windows.

The building is of stone from the neighbourhood, and was erected this year. The internal arrangements afford the usual accommodations of a badking establishment, and for the domestic requirements of the resident and manager, Mr. M'Lachlan.



NATIONAL PROVINCIAL BANK OF ENGLAND, DARLINGTON.—J. MIDDLETON, Esq., Architect.

DEVELOPMENT OF GEOMETRICAL TRACERY.

On the Development of Geometrical Tracery. By the Rev. G. A. Poole.—(Paper read at a meeting of the Architectural Society of the Archdeaconry of Northampton.)

It is sometimes objected to one who complains of a defect in any system of which he is treating, that he ought to produce a remedy for this defect. This, as a general proposition, would be at once rejected by every one, and yet, perhaps, every one is alike ready to apply it to those whom he does not affect, or of whose treatment of a subject he does not approve. And this, at least, must be admitted, that one who professes that he has seen the evil is not the last from whom the remedy may be expected. And having again and again felt, and professed to have felt, the inconvenience of the arrangement of Rickman, and of every architectural classification, where the style which intervenes between the Early English and the fully-developed Decorated is concerned, I shall now endeavour to justify my complaints, and to prove that there is such a generic difference between that style and the Early English and Decorated, on either hand, that it ought to have a distinct place in an architectural system and a distinct name in architectural nomenclature.

It is at once apparent that the styles of Gothic architecture are arranged very much with reference to the character of the windows. Right or wrong this is the case; and right it certainly is in the sense of being obvious and convenient; though it might perhaps have been expected that some more organic part of the structure might have afforded the characteristics of style. It should be considered, however, that the divisions of Gothic architecture are but sub-sections, or species; not kingdoms or genera. They are not analogous with the divisions of animals into vertebrate and molluscous, for this is parallel with the primary division of architecture into that of the arch and of the entablature. These grand divisions, then, being based on organic differences, it does not seem incongruous that the minor features of a building—even, if necessary, features far inferior in use and in powers of expression, to the window—should afford the differentials of genera and species.

The great point is, that the differences be constant and tangible; but here is the difficulty. There are facilities and difficulties in all systems, and in all parts of systems. It is easy to separate, in general, between a plant and an animal; it is easy to define the difference between the architecture of the arch and of the entablature; but there is a debateable province in both cases; in architecture the whole class of Romanesque buildings; in Zoology the countless species of zoophytes. Again, it may be as easy to distinguish, in general, between Decorated and Perpendicular as between a beast and a bird; but the buildings are countless which have as many of the characters of each style as the ornithorynchus has of the mole and of the duck. I wish this to be distinctly borne in mind all along, lest I should seem to fail in establishing a distinction; whereas, it is the very condition of all such distinctions that they shall have their vanishing point, not to the eye only, as where the sky seems to meet the earth at the horizon, but in the very nature of things.

And now what do we see, if we follow the forms of windows during the last half of the thirteenth and the first half of the fourteenth century? We see them gradually deserting the narrowness and simplicity of the lancet form, till, at last, they have arrived at a great variety and complexity, involving proportionate width of opening and the subordination of many parts. We see, in a word, a wide opening filled with mullions and tracery. And this tracery is composed, at first, of geometrical figures, following certain laws, and afterwards of figures no longer geometrical, and, though not without law, yet of that free flowing contour, which looks at least without restraint. Now, I think you will agree with me, that the first change and the last—the change from Early English to Geometrical, and the change from Geometrical to Flowing Decorated—both demand to be treated as the differentials of a style; the first, that is the mere introduction of tracery, as being, so far as windows are concerned, more important than the difference between Norman and Early English; the latter, the change of the laws which govern the formation of tracery, as being at least as important as any difference which separates Perpendicular from Decorated. In other words, Geometrical is more unlike Early English than Early English is unlike Norman; and so, *ex abundanti*, Geometrical and Early English should be separated; and, again, Geometrical is as unlike Flowing Decorated as Flowing Decorated is unlike Perpendicular; and, therefore, if the two latter should be distinguished, so also should the two former.

And yet, the Geometrical is almost always treated as transitional (which, indeed, every style but the first and last must be, in some sense; but I mean that this is so treated as transitional, as if it had no claim to a name and station of its own); it gets no better title than Late Early English, or Early Decorated, as the case may be; the term Geometrical being only adjected to the generic term Decorated, as marking, not a genus, but a variety. If this had no practical result, it would be little worth contending about; but I believe that it really does result in the too great neglect of this style, as a model, and, at the least, a point of departure for modern practice. A style which deserves, but does not obtain, a substantive position, is sure to be defrauded of more substantial proofs of the estimation in which it ought to be held.

It is not my intention to enter at length on the process by which tracery was gradually evolved from the juxtaposition and grouping of several lancets. This has been done often enough. I assume that you are all well acquainted with it, and commence from the time at which *Tracery*, properly so called, was freely used; from the time, that is, when the portions of wall which separated lancets were attenuated and moulded into mullions, and when the piercings of window heads had left no portion of intervening stone-work of greater breadth than the interlacing of two equal tracery bars required.

And now imagine yourselves walking round some great minster at night, when the interior is lighted. I know no better way of coming at the effect of the windows taken apart from the rest of the fabric. Let the nave and south transept be Early English, but let the choir have been built towards the end of the 13th century, and, consequently, with windows filled with Geometrical tracery. As you turn the corner of the transept and get the first glimpse of the Geometrical choir, you feel yourself carried into a new age of design and of construction. But the north transept is Flowing Decorated, or Perpendicular, I care not which. As you leave the choir, and get a sight of this portion, there are differences, indeed, plain enough, even though the windows only are visible, but they are as nothing compared with the difference between the nave and the choir. Or, in other words, the difference between two kinds of tracery is as nothing compared with the difference between tracery and no tracery.

But, say some, the only appreciable differences are those of the windows. First, for argument sake, I grant it; but I have shown why differences in the windows may very well become differentials of style. But, secondly, in truth, I deny it. I deny that there are no differences of characteristic details between the Late Early English and the Geometrical, and between the Geometrical and the Early Decorated. And I deny this the more emphatically, because I shall not now stay to point out the differences: I shall merely ask you to take my word for it, that they run through every part of the structure, in composition, in detail, in decoration, even in construction—the latter, indeed, being demanded by the change in a matter of so great mechanical importance as the relative proportions of the windows, which, you will remember, are arched piercings of the outer walls, of no small relative magnitude.

But, at present, I confine myself wholly to the windows, and even yet more exclusively to the tracery, omitting even to notice cusping, the natural correlative of tracery, except where it follows the same laws as the tracery, which, in the Geometrical style, and in that alone, it often does—so much so indeed that a drawing of the tracery of one window may be converted into that of the cusping of another, only by altering the scale.

The first impression conveyed by a Geometrical window and a Flowing Decorated window side by side, is, that while the former is obviously drawn wholly with the compasses, the latter seems at least to be drawn in some degree *libera manu*. Perhaps this impression, so far as the Flowing Decorated is concerned, is hardly correct; but you will presently see that it results from certain appreciable causes, and indicates a real difference of principle in design. Take the simple Geometrical and an equally simple flowing two-light window. The eye at once detects the use of the compasses in the one, and the very centres from which the curves are struck; in the other no single curve is sufficiently simple to be referred, except with considerable effort, to its centre or centres; it seems, indeed, to be drawn without any mechanical aid. Take more complex arrangement, and still the same character is found carried out through 3, 4, 5, 6, 7, 8, 9 lights. This alone, as it seems to me, is sufficient to demand a separation of the two styles; for in speaking of design, this very fact, that the designer is put into so different an attitude as that of one who is limited wholly

to geometrical forms, and of another who allows himself, or seems to allow himself the license almost of a sketch, is surely enough to separate between them.

But the free hand of the later designer had its rules too, and those rules were apposite to those of his predecessors, and this is really the differential which I shall propose. In designing a Geometrical window, the architect adhered to true circles, or parts of true circles, never flowing off into another curve struck from another centre. The ogee was unknown. Cusps,—besides a characteristic so remarkable that I must refer to it, though parenthetically (besides their being *let into the soffit*, instead of being *taken out of the chamfer*—besides this, cusps) were of circles, or parts of circles, struck from circles within the greater circle, independent of one another, but with absolute dependence on the centre of the first circle; these points were cut off by another circle, concentric with the first, or that which circumscribed the whole figure. Hence a transparency of purpose and a precision of effect in this style never afterwards attained. All is complete in itself; and each member perfect, either as a part or as a whole—a character which Professor Whewell abundantly recognises when he calls the Geometrical Complete Gothic.

It must be confessed, however, that something of sameness and of restraint resulted from the use of the compasses, restricted by so narrow laws. This was remedied in a subsequent development of the same style, which let in far greater variety; sometimes amounting almost to license, and yet I think not quite. Indeed, though the forms on which I am about to touch must have often struck us with surprise and pleasure, I think they have never yet been fully appreciated. Mr. Sharpe, in his work on 'Decorated Tracery,' alludes to them thus equivocally: "Towards the close of the Geometrical period there occurred some attempts at originality in the designs of window tracery. Becoming apparently dissatisfied with the extreme formality of the usual geometrical forms, several fanciful experiments were tried by the builders of this period, which, without betraying any symptoms of impending change, present—under forms which may still be termed Geometrical—very little similarity in their general outline to the (former) examples." Now this variety, which Mr. Sharpe seems to consider purely fanciful in effect and abnormal in structure, I shall endeavour to reduce to certain rules, and to elevate, by consequence, to a higher rank.

I admit that it is an escape from a certain very stringent law; but look at the result, and you will be pre-disposed to find in it a recognised rule of its own. In its effect it amounts to a sort of facetiousness of design; a juxtaposition of curiously associated and highly contrasted parts, but yet, without ever losing its precision; so that playfulness and repose are combined in it, just as they are in the most irresistible kinds of wit. Every thing is trenchant, piquant, scintillating, yet still retaining the very strongest expression of precision and *retenue*.

And how is this point gained? By the interlacing of two figures—to speak in general terms—similar, that is, each a square or triangle for instance, but of exactly opposite texture, one being composed of parts of circles struck from within, the other of parts of circles struck from without, the resulting figure (whereas, before, all were struck from within), which distinguishes this from the former variety of the Geometrical style: and yet they still continue always to cut, never to flow into one another, which distinguishes this from the Flowing Decorated. Here is, for instance, a trefoil from Beaumaris thus treated, and a square from Great Bedwyn, to which last example I shall recur presently. And there is, again, the same resemblance between tracery and cusping here, as in the earlier Geometric;—what is tracery at Beaumaris being cusping at Stoke Dry; what is cusping at Canterbury being tracery at Great Bedwyn. Now you will observe how these figures are formed—the pointed figure by curves from centres without, the rounded by curves from centres within the figure. And, as for the result, if I could stand with you before the windows, I should at once ask, and be certain of the answer—are they not riant and fanciful, yet still self-possessed and perfectly balanced?

That the fascinations of this new method should lead to license, cannot excite surprise. It must have done so to a vicious extent had the compasses ever fallen from the hands of the designer; but with this guarantee of precision, Fancy might almost disport herself at will. I have, however, already alluded to an instance in which she did a little overstep the bounds of sobriety. At Great Bedwyn, you have subsidiary tracery breaking in upon the gravity of a principal mullion, like Folly attempting to discourse with Reason in one of Moore's melodies. I do not think Beauty can be offended at the result, but Order may, and it has certainly a revolutionary aspect.

And, in fact, a revolution is not only at hand, but it is clearly indicated, notwithstanding Mr. Sharpe's remark that no symptom is betrayed of the approaching change. We have already drawn circles from centres sometimes within and sometimes without the resulting figure; presently we shall not only do this but also let those circles glide into one another, so as to form complex curves, and we shall have the flowing tracery of the fully-developed Decorated.

But, before we do this, let us attempt to assign names to the two kinds of Geometric tracery with which we have already formed acquaintance.

For the generic term, or that including the whole of that tracery which is formed of circles, or parts of circles, secants and tangents of one another, but never flowing into one another, we cannot hesitate in taking that commonly in use—*i.e.* Geometric. To supply names for its two sub-divisions is not so easy. It is now some six months past that I endeavoured to do this, in an article in the *Archæological Journal*, where I ventured to suggest the terms Concentric and Excentric, to express the opposite characters of the two divisions. The first, you will observe, is of patterns formed of circles, or parts of circles, all the centres of which are within the resulting figure; and, as the figures are all uniform, even the subordinate parts must be repeated with the same necessary relation to the general centre. Thus, in a circle enclosing six other circles, grouped around a seventh (as at Grantham), the centre of the seventh is the same as the centre of the containing circle, and the centres of the six others all lie in the circumference of another circle drawn from the same general centre. All form one system, bound by a sort of centripetal force to one centre. The term CONCENTRIC is, therefore, at least intelligible, as applied to this variety of Geometrical tracery.

The other variety is formed by a combination of curves, some of which are struck from centres without the resulting figures; and, if the window is sufficiently complex, these other centres fall within other patterns in the same window, giving, by a centrifugal influence, to the curves to which they belong, a place in another system with another centre. And the term EXCENTRIC seems sufficiently appropriate to this development of tracery—to this group of architectural comets. We have, therefore, *Geometric* for the whole style, and *Concentric* and *Excentric* for its two varieties.

And now we return to description, and to the successive changes of tracery, which we left on the verge of a revolution.

The use of figures composed of parts of circles, some within and some without the resulting figures, had commenced; and this had also the effect of giving to several figures a reciprocal interest in the parts of each other. And this which was partially effected in the Excentric Geometrical, is fully attained in the Flowing Decorated, where the curves run into one another, and each line becomes a part of the boundary of two figures, of one without, of another within, the influence of its own centre.

There are one or two curious results from this.

In the first place, the great variety and the double importance of the lines of the tracery tend to make these the principal object of attention, and whereas before the lines were used to form the lights, now the lights are made to adapt themselves to the lines—a manifest lowering of principle, since mullions are clearly for windows, and not windows for mullions.

Secondly, there is a great tendency to sacrifice apparent security to grace of form. Some Flowing Decorated windows look as if they could not stand without the influence of the window arch, as if the parts were unequally balanced, and a disproportionate weight was laid upon the feeblest part of the feeble curve. This never happens in a Geometrical window.

Thirdly, the patterns are enabled, by accommodating curvatures, to run into every corner of the space to be filled, and the interstitial spaces, which in Concentric tracery are generally triangles, and in Excentric tracery are multiform, either entirely disappear or are made so large as to have their own part in the composition and their own cusping. This is, I think, the only decided advantage which the Flowing has over the Geometrical style, and this is too dearly purchased.

I do not propose to carry my remarks into the subdivisions of Flowing tracery; and I shall therefore be content with giving you one type of it, the common reticulated tracery, which exemplifies almost all that I have said. Here parts of circles, drawn alternately from within and from without the figures which they form, compose the whole of the design; each curve is a part of two figures, and the spaces left by the tracery appear only at the

window arch, where the pattern is as arbitrarily cut off as a piece of damask could be with the scissors of the mercer's apprentice.

One objection will be made to all that I have advanced. There are cases where my definitions and descriptions will not absolutely hold. In the window of Great Bedwyn, for instance, there are several ogees. In the east window of Market Harborough, parts of the design are Geometrical, part Flowing Decorated; and so of many other cases. This is very true. But remember that we agreed, awhile ago, that this must always be so, and indeed, it is the case equally with Decorated and Perpendicular, and with all the styles. In Kirkstall, Fountains, and Buildwas, what would be called Norman, if seen alone, actually occurs over what would be called Early English. In Patrington, Yorkshire, the east window is pure Perpendicular, all the rest is Decorated. In many other churches we have windows which cannot be historically separated, yet which cannot architecturally be classed together. These are difficulties which occur now and then, and must occur. Yet they do not render it less necessary to call this or that building as a whole, Norman or Early English, Decorated or Perpendicular. I only claim for the Geometric style the same indulgence.

Directly or by inference I find others agreeing with me in demanding that the Geometrical shall be acknowledged as another style. Mr. Sharpe, for instance, in his work on 'Decorated Window Tracery' (to which I cannot allude without adding a word of very high commendation,) having defined the difference between the windows in what used to be called Early and Late Decorated, adds, "We have only to carry our inquiries a step further in order to satisfy ourselves that these points of difference are not confined to the windows alone, but extend also to the buildings to which these windows respectively belong; and, having arrived at this point, we shall not be long in coming to the conclusion that there exists a large and important class of buildings, characterised by the Geometrical forms of their window tracery, which has hitherto been treated as belonging partly to the Early English and partly to the Decorated style, but which is, in reality, distinct from both, and pre-eminently entitled, from the number and beauty of its examples, to separate classification."

I had hoped, indeed, that before this Mr. Sharpe would have published, with ample illustrations, his own arrangement and nomenclature. In what I say now I would rather be considered his pioneer than as having any substantive importance of my own. Some time past I stated my views to him on this subject, and found that his were already in a far more produceable shape, and I doubt not that he will soon formally claim the title Geometrical, not only for a certain character of window tracery, but for the style of architecture in which it is found.

Again, I find that Mr. Freeman, in his 'History of Architecture,' where he divides all Gothic architecture into two great classes, Discontinuous and Continuous, actually places his one broad line of demarcation where, at present, all distinction is sometimes denied, between Geometrical and Flowing Decorated.

Finally, Mr. Scott, in his 'Plea for the faithful Restoration of our ancient Churches,' a work which is of great interest to the people of Northampton, since the restoration of St. Peter's church is committed to him, and which has few competitors in general importance, claims not only a place, but the highest place, for the Geometrical style. But what he says is too long to be transcribed at length, and too important to be retrenched. I must, therefore, refer you to his chapter *On the Choice of a Style for present Adoption.*

I am not very favourably situated for reference to books here, therefore, my appeal to the judgment of others closes; but not without a formal assertion of the principal objects of my paper. Let us uphold the right of the Geometrical to a place, and that the highest place, among the distinct styles of Gothic architecture.

I fear that the method of my discourse has not tended to produce the impression that I have been wandering with you along one of the most *flowery* paths of architecture; and yet this is really the case. But you must remember that I have been playing the part, not of the florist, but of the botanist, who is, in comparison, a very dull sort of fellow. Nowhere is THE BEAUTIFUL, for its own sake, more visibly the object of the architect than in the disengaging of tracery, and nowhere has that object been more happily attained. Here he works, to borrow an expression of Ruskin's, as if he was happy as he worked; and we follow him in his task with an ever-growing interest, and look delighted on each successive form and character which he evokes from his stubborn materials. The first germ, hidden from all eyes but those who watch for spring with the impatience of love—the swelling bud, veiling yet promising countless forms and hues of beauty—the bursting flower, compact yet full, glowing yet half coy in conscious loveliness, and all the sweeter for its coyness and reserve—the leaves expanding with a new vigour, crisped with life yet still crumpled with the kindly compression from which they are escaping—the bright smooth petals of the wide-spread flower, tremulous with exultation, and but too ready to fall in their redundant beauty, when Winter, envious or too rigidly severe, lays his icy hand upon them lest they should become wanton in their exuberance—such, almost, are the forms which we have now reviewed in their order and their destiny. We have seen the first germ of tracery hiding countless beauties. We have seen it expanding, but yet under the most severe restraint, in the first or Concentric tracery. We have seen it put forth more fantastic forms—let me repeat the very words, the crisped and crumpled forms—of the Excentric or Later Geometrical; and, finally, we have seen the widely-expanding, half-flaunting, half-fletri Flowing Decorated, stiffened at last, and not undeservedly, into the harsh and hard, soulless and sapless Perpendicular. Oh! that we might be allowed to anticipate a return to the opening bud, and its expansion into another flower of a higher kind of beauty and a better fate!

VERANDAH, SANS SOUCI, NEAR BERLIN.

The above engraving represents the Verandah of a Flower Window in the head gardener's lodge at Sans Souci, the royal seat of the King of Prussia, near Berlin.

According to the *Annales des Chemins de Fer*, an arrangement has been made by the directors of the North of France and Strasburg Railway Companies, that they will, at common expense, build a line of communication, which will start from the De la Chapelle Goods Station, transect the national line No. 1, from Paris to Calais, the rural roads des Fillettes and la Croix des Evangiles, and join the Strasburg line about 150 yards above the viaduct of the Rue des Tournelles. The whole length of this railway, from one line to the other, will be 1200 yards. When, however, the important plan of a circular line, which will bind together all the lines starting from Paris, shall have been completed, the junction of the North and Strasburg lines will be effected by a small branch line of about 300 yards, which will branch off from the main line of junction. The line will have but one rail, and will be worked by horses, as the space to be traversed is very short.

VENTILATION AS A BRANCH OF SANITARY REFORM.

On Ventilation as a Branch of Sanitary Reform. By WILLIAM WALKER, C.E., of Manchester.—(Paper read at the third meeting of the Liverpool Architectural and Archæological Society, November 13th, C. Barber, Esq., V.P., in the Chair.)

MUCH had been said latterly about sanitary affairs, and the public health was becoming a leading topic of the day. We had instituted Boards of Health and a Sanitary Commission; several statesmen and men of influence, actuated by motives of philanthrophy, had taken the question under their especial protection, but, notwithstanding this, comparatively little had been done to remedy the evils complained of. True it was, that during the sway of the fatal epidemic last year, temporary expedients were adopted, and a spur was given to sanitary progress. Since that time more copious supplies of water to some large towns, and some few drainage works for removing rapidly accumulating refuse had been undertaken. In public buildings, too, of late years, great attention had been paid to the ensuring of copious supplies of air. The new Houses of Parliament, at Westminster, and St. George's Hall, in Liverpool, were the latest instances of this; the latter of these buildings was, however, so far from completion, that no trial had yet been made of such measures as were adopted during the construction; and, if we might judge from the public prints, doubts seemed to be entertained of their efficiency, so far at least as might be implied from the devoting of a sum of money and a considerable period of time to the trial of further experiments as to the best mode of ventilating it. The walls being apparently completed, the question arose whether that was not beginning at the wrong end, and whether the experiments ought not to have preceded the construction, in order to obviate those difficulties and expenses which must result should the experiments involve a necessity for constructive alterations?

Branching forth into the historical portion of his subject, Mr. Walker said, that if we carried the ploughshare of research into the early days of architecture and engineering, we should find much to astonish us in the progress made by "the world's grey forefathers" in the arts conducive to health. The Roman aqueducts furnished magnificent testimony to the care bestowed by the ancients on cleanliness as a means of health; and Greece, also, made similar provision for her people. The system of sewerage adopted by the Romans was of the most efficient and extensive character. They did not enter into fierce debate whether a six-inch or a nine-inch pipe would suffice, the minimum system not being in force in those days, but they took care that if they erred, the error should be on the side of excess rather than of deficiency. We were only just beginning to establish public baths for all classes, and it was thought to be a great step in advance—but both the Greeks and Romans, and probably the Egyptians before them, had theirs; and the art of heating their buildings and their baths was not unknown to the luxurious Romans. As to the change of air (the more immediate object of this essay), there did not appear to be any special provision for that purpose adopted by the ancients, except by the windows. Change of air was deemed by Vitruvius to be of the greatest importance, but his directions applied almost exclusively to external provisions and arrangements. The moderns had only recently begun to follow the ancient practice of providing open air walks or public parks for the people in large towns, but so far they were on a very inefficient scale; their great distance from the spots where the day was spent in toil, rendering the fatigue of reaching them a great barrier to their use. This objection was anticipated by the Romans, who provided them at all their bathing establishments, theatres, and other places of great public resort. During the "dark ages," which succeeded the decline and fall of the Roman empire, these and many other arts, if not entirely lost and forgotten, fell, at least, into neglect and desuetude; and from that long period of sanitary darkness we were only now, by slow degrees, emerging.

The two natural fluids chiefly concerned in the sanitary art were water and air. The first of these—water—was provided for our use in the greatest abundance—three-fourths of the surface of our planet being covered with it; but air was provided for us in an infinitely greater abundance even than water, the entire surface of the globe being covered with it to the height of about fifty miles.

After treating of the chemical properties of air, Mr. Walker came at once to the subject of Ventilation, which he took to imply motion of air; and where there was motion there must be a mover. In the great process by which the earth was ventilated, heat was the mover, and its effects met with no interruption from opposing circumstances. The earth was not closely hemmed in by other planets, which might obstruct those movements; nor could the inequalities of its own surface offer any serious impediment to the free progress of those enormous volumes of air, compared with whose vastness the highest mountains and deepest valleys might be regarded as almost a level surface. This was natural ventilation, and as in all the processes of art the imitation of nature was our primary rule, so should we best succeed in ventilation by adopting her measures and following her infallible processes. But we must ever bear in mind that we were not ventilating a smooth, free, and unobstructed ball like the earth. Our art was to be exercised upon the artificial and complicated works of man, who surrounded himself with walls which other men surrounded with other walls; who protected himself from the inclement winter by transparent inclosures; who in progressive stories heaped one building on another; who, in fact, multiplied artificial contrivances for other purposes, each one of which removed him further from a state of nature; whose arts, forms, and usages brought large numbers into an unnaturally small space, and who must therefore use further artifice to obtain that natural supply of the vital element, which his previous wants and proceedings shut him out from. Ventilation was not simply a summer question. At all seasons of the year we must have air. Not only must it be supplied, but means must be resorted to to obtain it at a proper temperature, and to introduce it into our rooms and around our persons in an unobjectionable manner. These considerations at once set at defiance all those numerous devices of the "passive" or (so-called) "natural class," which consisted in admitting air directly into rooms through openings in the windows or external walls. In the rigours of winter they afforded no means of modifying its coldness, and those who might have, inadvertently, to sit near them would testify to the injurious result. Most of them, indeed, carried with them their own refutation, being provided with means by which they might be entirely closed; and so far as his opportunities of investigation had gone, they were mostly very judiciously kept closed in very severe weather. Window ventilators were also open to another very serious objection, which was that in the evening, when dwelling-rooms were most closely inhabited, the gas lighted, and vitiation in its fullest force, that was the precise time when the closing of the shutters put a total stop to the action of the ventilators. All modes of admitting air in winter which did not proceed on the principle of modifying its temperature at or before the moment of its entering, would, however much diffused the openings might be, produce great inequalities of temperature, and frequently also cold and dangerous draughts of air. Mr. Walker then proceeded to point out how large quantities of fresh air might be introduced with certainty into the various compartments of a building, illustrating his views by some examples which had been carried out. In nearly every case constructive preparations had been necessary: the mode of obtaining air had been considered when the building was originally planned, and by the concert thus established between the architect and the ventilator, successful results had been obtained at a minimum cost.

Mr. Walker deferred till a future occasion the more practical part of his subject, which would refer chiefly to the means, constructive and otherwise, which would ensure a supply of air being obtained in proper quantity, manner, and condition.

Remarks.—Mr. RAWLINSON (Inspector to the General Board of Health) said this was a subject that he had paid special attention to for some time, and he might, perhaps, be allowed to make a few remarks upon it. He quite agreed with Mr. Walker, that it was time architects took up the subject, and that ventilation should be considered in the structure of buildings. If it was necessary to put a roof upon four walls, it was quite as imperative to make provision for the due regulation and escape of air. Any attempts at ventilation after the house had been occupied, or even the adoption of so-called "ventilators," in chimney breasts, were mere make-shifts. They did not give that which was required—namely, full, free, copious, and safe ventilation. To be safe, ventilation must be diffused; it must also be perfectly under control. He had no hesitation in saying that a well-built house of modern construction, in the metropolis or Liverpool, was the most dangerous tenement that a man could put his head into. He lived in a London house, which was so well built that the door vibrated like an Æolian harp. When he sat by the fire writing, he had to resort to the expedient of turning a bucket the wrong side up to put his feet upon, in order to escape the ill effects of the draught, the fireplace being low. He had no doubt that many literary men who became absorbed in their subject, and got their heads heated whilst their feet were cold, from the draughts which crept along the floor, had their

constitutions materially affected from want of the necessary precautions. He expressed his opinion that the corridor, lobby, and staircase of a house should be well warmed, which would do away with those cutting draughts that crept along the floors and were so injurious in winter. St. George's Hall had been alluded to, and Mr. Walker was, perhaps, not aware that Mr. Elmes paid considerable attention to the subject of ventilation in the construction of that building. Every arrangement was made that he (Mr. Elmes) considered necessary, and the assistance of Dr. Reid was called in. The great vaulted ceiling which was turned over the hall had had especial reference to ventilation. Allusion had been made to the ventilation of cottage tenements. As inspector to the Board of Health it had been his duty to travel through the length and breadth of the land, and he had visited tenements of all descriptions. Doubtless many gentlemen in that room had read the statements drawn up by men in office, and imagined them to be overcharged; but he could assure them that there did not exist a man who could adequately describe the utter wretchedness in which the lower classes of this country lived in the nineteenth century, and in the midst of boasted civilisation and refinement. This was not the case in large towns alone, but it was the same in rural villages where Irish emigrants took up their abode. It was laid down as a law that 800 feet of air was necessary for each individual; and he had seen thirty persons snoring fast asleep where there should have been but two. It was high time that this state of things should be altered. He followed the track of the fearful epidemic last summer, and, if he was shown a tenement or house, he could tell whether fever or the cholera would come there or not: there was no mystery about it. If people were crowded together where there was no means of obtaining fresh air, where refuse had accumulated for a long period, there fever would make its visitations, and in times of epidemic the cholera would take up its devastating abode. It was also singular that damp had a great deal to do with it. It was not enough to make the surface dry, but the subsoil should also be in like condition. Something had been said with regard to ancient and modern drainage; and it was certainly very right that we should admire and imitate, so far as we could with advantage, all that had been done by the ancients; but we should be doing very wrong if we followed the example of the Romans, in their large sewers. Mr. Rawlinson contended that the minimum sized drains were most efficient, and that those which were large only afforded space for deposit. Again adverting to the subject of ventilation, he recommended the application of hollow bricks or tiles, which, he said, now that the duty was off, might be made of any size or form. He had made an experiment to test the capabilities of these bricks to carry pressure, doubts having been expressed as to those on which the great ceiling of St. George's Hall was turned, and he found they were capable of sustaining the required weight.

Mr. Barber asked if the ceiling to which Mr. Rawlinson alluded was turned at his suggestion?

Mr. Rawlinson said it was. The construction of that ceiling gave a great deal of trouble, but it was always Mr. Elmes' intention that he (Mr. Rawlinson) should turn it for him. He had seen at Castle Howard some tile piping, and he did not see why he could not turn the arch of St. George's Hall with them; he had some made with two-inch bore, four inches square, and twelve inches long, which answered the purpose very well.

An interesting discussion ensued, in which Mr. H. P. Horner and Mr. J. Boult took part, dwelling on the importance of large buildings, such as St. George's Hall, as they were not only an ornament to the town, but promoted public health by the open space which was left around them, besides which they called forth improvements in construction, and in sanitary arrangements, which would not otherwise be thought of.

MEMOIR OF THE LATE WILLIAM MURDOCK.

On the Inventions and Life of the late Mr. William Murdock. By Mr. Buckle, of Soho.—(Paper read at the Institution of Mechanical Engineers at Birmingham.)

The subject, interesting in itself, was rendered peculiarly so by the exhibition of several mechanical antiquities, among which may be specially noticed a diminutive locomotive engine, constructed by Mr. Murdock in 1784, and unquestionably the first that ever was made. A bust of the deceased mechanician, by Chantrey, was appropriately placed in the room, and the Rumford medal, awarded to him by the Royal Society, was inspected with interest by the members. The chairman prefaced the subject by observing, that he had the distinguished honour of exhibiting to the present, as the first public Scientific Institution, the very first locomotive engine ever constructed. To the late William Murdock belonged the honour of producing it. He was at that time at Redruth, in Cornwall, and having conceived the idea of making a locomotive, he carried it into effect, as the interesting piece of mechanical antiquity then exhibited, would best testify. A very curious anecdote was preserved in connection with it. On one occasion, having placed it on a gravel walk conducting to the church at Redruth, he lighted the lamp beneath the boiler, and whilst the locomotive was pursuing its course, to the singular dismay of the clergyman of the parish, it attracted his notice, and he fancied that the evil one himself was making night hideous.

The paper was then read by Mr. Marshall, secretary to the Institution. It commenced by observing, that the subject of his notice was born at Bellow Mill, near Old Cumnock, Ayrshire, in 1754, where his father, an ingenious mechanic, carried on the business of millwright and miller. His mother's maiden name was Bruce, and she used to boast of being lineally descended from Robert Bruce, the Scottish hero. So remarkable a man, whose talents and inventions have contributed to the advantage of society, and whose ingenuity was so well known, should not be allowed to go out of the world without some special notice. Little was known of his habits and pursuits prior to his joining the establishment of Messrs. Boulton and Watt, at Soho, in the year 1777, then in its infancy; but he must, before he left his native country, have had celebrity, as he was employed to build a bridge over the river Nith, in Dumfries-shire—a very handsome structure which still exists. His talents were soon justly appreciated at Soho, particularly by the celebrated James Watt, with whom he continued on terms of the warmest friendship to the time of Mr. Watt's death in 1819. After a short residence of about two and a-half years at Soho, he was appointed by Messrs. Boulton and Watt to superintend the erection and undertake the general charge of their engines in Cornwall, where he erected the first engine with the separate condenser in that district; and he remained there, giving great satisfaction to the mining interests, until 1798, when, as a proof of his usefulness, the adventurers in the mines, hearing of his intention to return to Soho, used all their efforts to retain his services, and offered him 1000*l.* a-year to remain in Cornwall; but his attachment to Soho and his Soho friends would not allow him to comply with their urgent request.

In the year 1785 he married the daughter of Captain Painter, of Redruth, Cornwall, and had four children, of whom only one son survives; his wife died in 1790, at the early age of twenty-four years. In 1798, Mr. Murdock returned to Soho to take up his permanent residence, and superintend the erection of the machinery at the foundry connected with that establishment; but he occasionally superintended the erection of engines at a distance, and among others those of Lambeth, Southwark, Chelsea, New River, East London, Westminster, and Essex water-works. His energies to further the interests of Soho were not employed in vain, for they assisted in no slight degree in procuring for it a name celebrated throughout the civilised world. His time, whilst at that establishment, and for years afterwards, was so completely occupied by his mechanical pursuits, that he had no leisure to devote to any sort of relaxation. The rising sun often found him, after a night passed in excessive labour, still at the anvil or turning-lathe, for with his own hands he would make those articles which he would not trust to hands less skilful. Mr. Watt, in his notes on Dr. Robison's 'Treatise on the Steam-Engine,' bears testimony to some of Mr. Murdock's valuable improvements, and others are recorded in a patent he took out in 1799. These, although described by the writer in detail, may be briefly indicated as boring cylinders by means of an endless screw working into a tooth-wheel; beam cases for cylinders cast in one piece, fitted to the cylinder with a conical joint at top and bottom; the double D slide valve for simplifying the working of the steam-engine and saving the loss of steam; the cylindrical valve for the same purpose as the preceding one; and a rotary engine, consisting of two wheels with both working into each other, and fixed in a case fitting close to the sides of the two wheels and the ends of the teeth, these parts being made steam-tight by packing. Mr. Murdock had one of these engines, of about one-horse power, set to work about 1802, at Soho Foundry, to drive the machines in his private workshops; it continued there for about thirty years, and afterwards in nearly constant work, was found to work well.

First Locomotive Engine.—Now that locomotive steam-engines applied to carriages have become so extensively used, it is proper

to record that the first so applied was made by Mr. Murdock, upon the principles described in the fourth article of Mr. Watt's specification of 1769—since adopted in all engines for that purpose; and this was seen in 1784, by persons still living, drawing a model wagon round a room in his house at Redruth, where he then resided. This original engine was frequently exhibited by him to friends at his house at Handsworth up to the time of his death, and is still in working order. (The identical engine was at a subsequent period of the evening set to work, to the extreme interest and evident satisfaction of every one present.)

At the time that he was making experiments with his locomotive engine, he greatly alarmed the clergyman of the parish of Redruth. One night, after returning from his duties at the mine, he wished to put to test the power of his engine, and as railroads were then unknown, he had recourse to the walk leading to the church, situated about a mile from the town. This was rather narrow, but kept rolled like a garden walk, and bounded on each side by very high hedges. The night was dark, and he alone sallied out with his engine, lighted the fire or lamp under the boiler, and off started the locomotive, with the inventor in full chase after it. Shortly afterwards he heard distant and despair-like shouting; it was too dark to perceive objects, but he soon found that what he heard were cries for assistance proceeding from the worthy pastor, who going into the town on business, was met in his lonely road by the fiery monster, whom he subsequently declared he took to be the Evil One in *propriâ personâ*. Whoever has been on one of our modern railroads on a dark night, and seen an approaching train—now no novelty—may easily imagine what effect the awful sight would have on the nerves of an elderly gentleman of the last century; and, although the demon was of small dimensions, yet it was a total stranger, and quite unlooked for in such a locality.

Gas Lighting.—Mr. Murdock is still better known to the public by his invention of applying the light of gas from coal to economical purposes. In 1792 he employed coal gas for the purpose of lighting his house and offices at Redruth, in Cornwall; and this appears to have been the first idea of applying the light to useful purposes, although the gas had been discovered and obtained both naturally and artificially, more than half-a-century before. He had also a gas lantern in regular use for the purpose of lighting himself home at night across the moors from the mining engines that he was erecting to his house at Redruth; this lantern was formed by filling a bladder with gas, and fixing a jet to the orifice, which was attached to the bottom of a glass lantern, the bladder hanging underneath. After various experiments, whereby he proved the economy and convenience of light so obtained, he made a public exhibition of it by lighting up the front of Mr. Boulton's manufactory, at Soho, on the occasion of the general illumination for the peace of Amiens in 1802. He subsequently lighted up some cotton mills at Manchester, beginning with that of Messrs. Phillips and Lee; and he published a paper, describing the advantages, in the Philosophical Transactions for 1808, for which the Royal Society presented him with their large Rumford Gold Medal.

Water Pipes.—In 1810 Mr. Murdock took out a patent for boring pipes for water, and cutting columns out of solid blocks of stone. A machine, constructed according to his principle, was set to work at Soho, and another at Mr. Rennie's works, in London; but the patent was subsequently sold to a company in London, with the object of supplying water of greater purity, by conducting it through stone instead of iron pipes.

Blast Engine.—In 1802 he applied the compressed air of the blast engine employed to blow the cupolas at the Soho Foundry, for the purpose of driving the lathes in the pattern shop, by using it to work a small engine with a 12-inch cylinder, which was connected with the lathes, the speed being regulated as required by varying the admission of the blast. This engine continued in effective use for about thirty-five years, and was only discontinued on the occasion of an alteration of the shop. He also constructed a pneumatic lift, and applied compressed air to ring the bells in his house. With this latter invention Sir Walter Scott was so much pleased when he once saw it in operation at Mr. Murdock's residence, that he had his own house at Abbotsford fitted up in a similar manner by Mr. Murdock. He was the inventor of the cast-iron cement, since of so universal and important a service in the construction of machinery; and he made several experiments on the projectile power of high-pressure steam. A specimen had been preserved, and was now exhibited to the meeting, of a leaden ball, about an inch in diameter, which he fired from a steam-gun against the wall of the Soho Foundry in 1803, as the date inscribed upon the ball bore testimony. Allusion was made to several curious incidents manifesting his ardour of research and carelessness as to personal appearance. In 1815 he erected an apparatus, of his own invention, for heating the water at the bath at Leamington. The first conservatory heated in this mode was that of his son, at Handsworth, which remains in use to the present day.

In his latter years his faculties, both corporeal and mental, experienced a gradual decay, and he lived in absolute retirement. He died on the 15th of November, 1839, aged 85 years; and his remains were accompanied by several old and attached friends, and by the workmen of Soho and Soho Foundry, to their last abode in Handsworth Church, and are there deposited near those of Mr. Boulton and of Mr. Watt. A bust by Chantrey serves to perpetuate the remembrance of his manly and intelligent features.

After the paper was read a brief discussion ensued, in the course of which Mr. Middleton, who described himself as "an old Sohonian," endeavoured to show that the pneumatic lift so well known in Staffordshire, and by members of the Institution, in consequence of Mr. Gibbons' recent paper, was the suggestion of Mr. Murdock, who was entitled to the merit of the invention. To this view Mr. Slate demurred, and said he thought that the invention described by Mr. Gibbons depended upon a principle mechanically different to that described by Mr. Middleton. The discussion was brought to a close by the chairman, who said he thought they must all have been struck with the very affecting exhibition which they had witnessed of that feeling of attachment which, to the present moment, continued so strong in the minds of all those gentlemen who had been connected with those who might fairly be called the patriarchs of mechanical and engineering science in this country. It had been intimated, as a very striking instance of the use of institutions like the present, that Watt, Boulton, Wedgwood, Murdock, Keir, Dr. Darwin, Dr Withering, and Dr. Priestley, were the members of a "Lunar Society," so called because their meetings took place at the occurrence of the full moon. Hence we had Boulton's medals, Wedgwood's medallions, Watt's important discoveries, Keir's experiments in chemistry, Dr. Priestley's discoveries in philosophy, Murdock's numerous inventions, and Dr. Darwin's poetical prophecy as to the power of steam. This was an interesting fact, as showing the advantages resulting from the interchange of thought between men of scientific pursuits and mechanical genius.

THE GREAT EXHIBITION BUILDING—CONSTRUCTION OF THE ROOF.

Some remarks having been made by us in the *Architect* of the 16th ult., in reference to the ultimate stability of the Exhibition building, they have, we are glad to learn, been most carefully weighed by the authorities, and are likely to meet with attention. Indeed, it is only by careful consideration in the beginning that eventual evils can be successfully precluded, and satisfactory grounds be laid for public confidence in a new and untried undertaking, in the prosecution of which to its completion the national reputation is now at stake. We must neither leave off in our progress, nor must we carry it on to subject ourselves to discomfiture.

In the following semi-official communication in the *Times*, we do not wholly concur; but it contains many points of interest, and shows that the authorities are disposed to make alterations where they may appear requisite:—

"There not only was greater care requisite in order to give rigidity to the central and most trying point of an edifice where safety and strength are so imperatively necessary, but the task of construction presented greater novelty of detail and less sameness of combination, as will be easily understood from the plan. In the first place, with reference to strength and stiffness, the whole structure was, in the opinion of experienced architects—men well qualified to pronounce an opinion—deficient in what is technically termed 'diagonal bracing'—a principle of construction introduced by Sir Robert Seppings into the building of our larger ships, and the importance of which to an edifice like 'The Crystal Palace' will be readily conceived. This mechanical appliance had not been included in the plan, because it was believed to be unnecessary, and likely to prove cumbersome. Messrs. Fox and Henderson, the contractors, still express a confident opinion to that effect, and adduce proofs drawn from slight accidents that have occurred in the course of the works in support of their views. Their most experienced hands also declare that at the top of the third tier there is at present less vibration than at the top of most houses in

the metropolis. Notwithstanding all this, however, the building committee have determined that, in the centre at the points of junction of the transept and principal aisles, and also at the extremities and other parts of the building, where any strain is likely to be unduly felt, 'diagonal bracing' shall be introduced. We are strongly inclined to think that in this they have exercised a wise precaution. It is no doubt true that the lightness of construction contemplated by the design of Mr. Paxton may be apt to excite apprehensions of insecurity which are unfounded; but where the slightest doubts are entertained by persons well competent to form an opinion, it is obviously best to err on the safe side."

We have never faltered in our opinion of the ingenuity displayed by Mr. Paxton and his colleagues in the design and in the execution, and we are strongly of opinion that the Exhibition Building will exercise a material influence in extending the range of architectural exertion, and in improving the practice of construction. There is scarcely a part of the building in which some new mode of construction has not been adopted—some new application of mechanical skill, or some economical arrangement been brought to bear. Some things have yet to be tested by experience; but some are patent and decided results, from which example may be already taken. Thus the building has peculiar interest to practical men, and we are glad of every opportunity of giving information with regard to it.

The portion we are now able to illustrate is the structure of the roof; and we shall, as far as possible, conform to Mr. Paxton's own description given at the Society of Arts last week. This subject is of the more interest as Mr. Paxton has for many years made it his particular study, and he has peculiar opportunities of investigating the construction of light roofs.

In 1828, the various forcing-houses at Chatsworth were formed of coarse thick glass and heavy woodwork, which rendered the roofs dark and gloomy. His first object was to remove this evil, by lightening the rafters and sashbars, which was done by beveling off their sides. He also contrived a light sashbar having a groove for the reception of the glass; this groove prevented the displacement of the putty by the sun, frost, and rain. In horticultural structures, such as Mr. Paxton was engaged in, it is of particular importance the light and heat of the sun should not be obstructed; it was therefore his object to get, as far as possible, a glass roof, and thereby a light roof.

Most of the rays of light and heat were obstructed by the

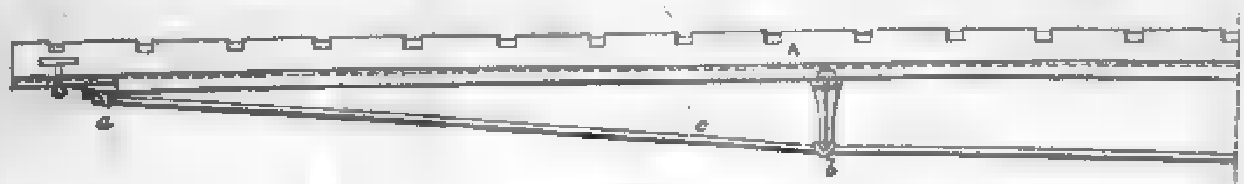


Fig. 1.

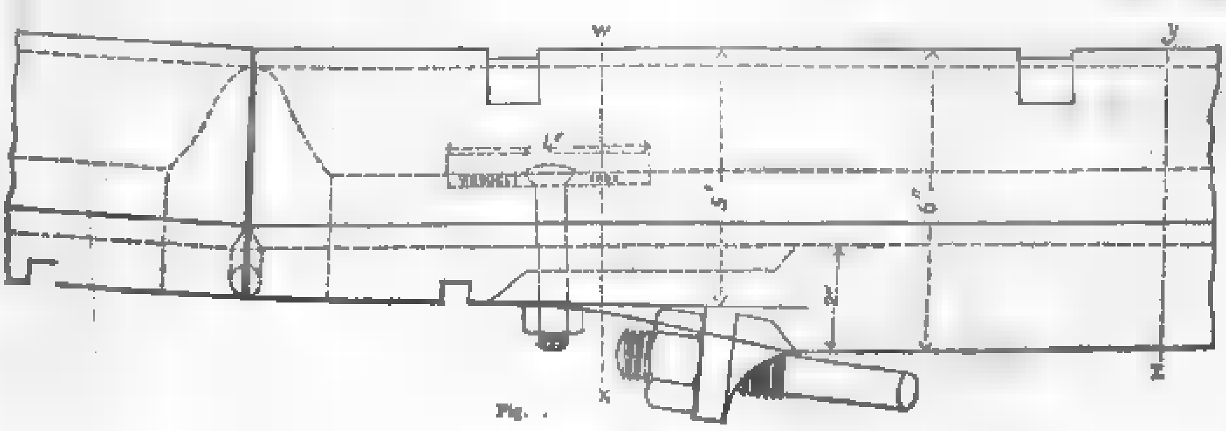


Fig. .

Fig. 5.

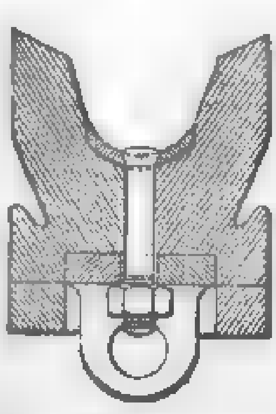


FIG. 3

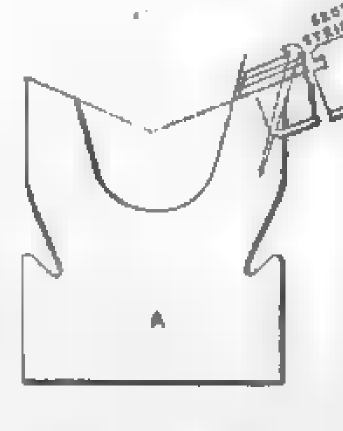
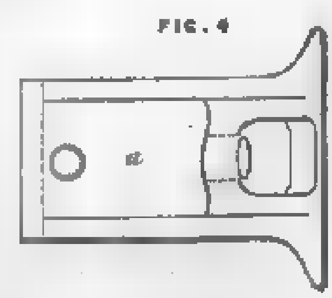


FIG. 4



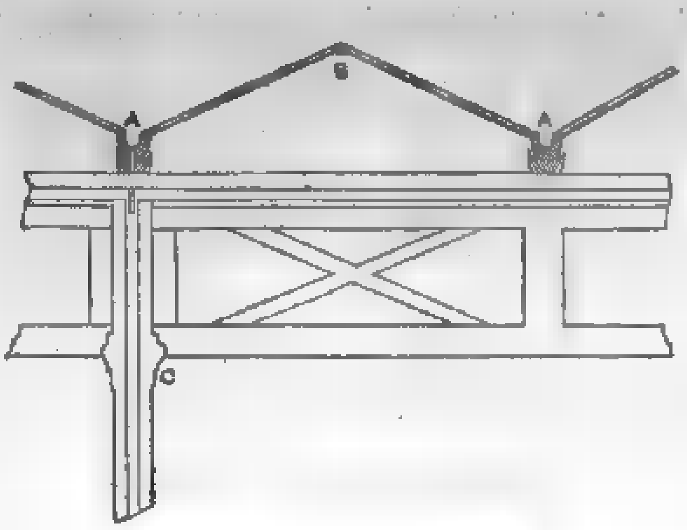


Fig. 6.—Transverse View of Ridge-and-Furrow Skylight.

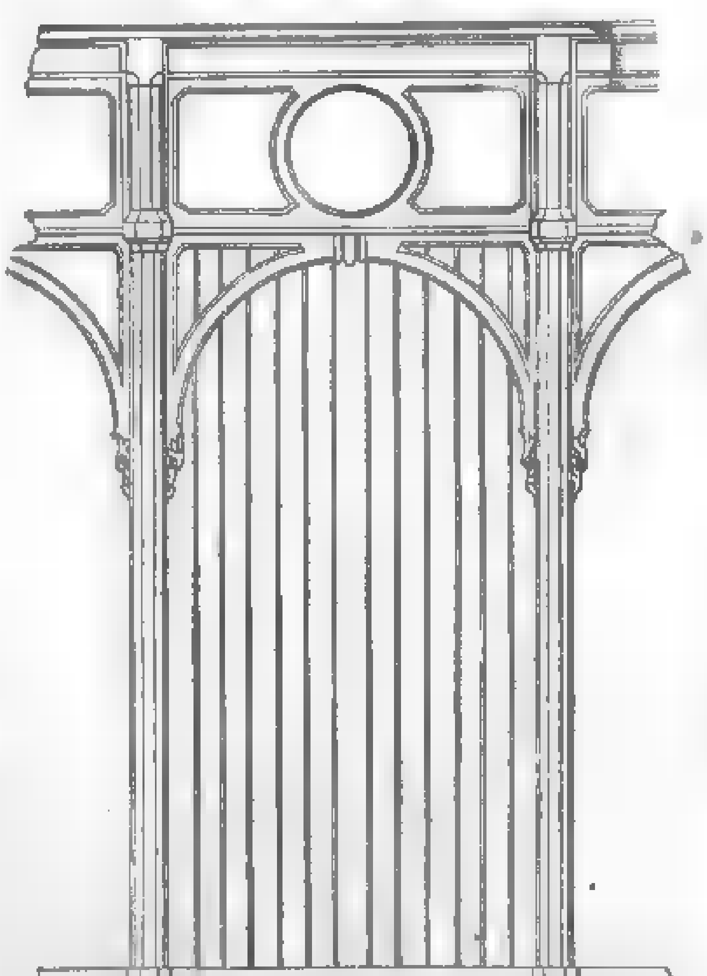


Fig. 7.—Lower portion of Exterior.

position of the glass and heavy rafters. This led him to the adoption of the ridge-and-furrow principle, which places the glass in

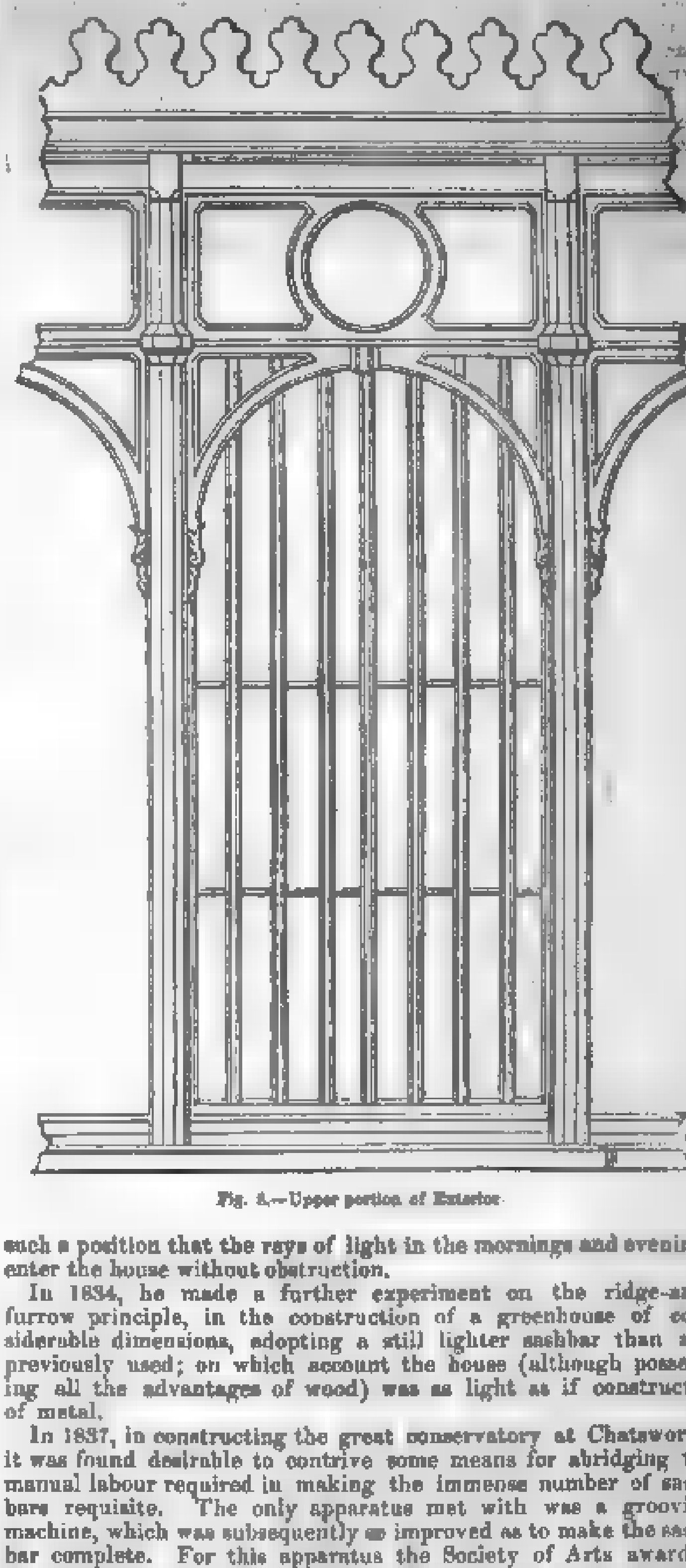


Fig. 8.—Upper portion of Exterior.

such a position that the rays of light in the mornings and evenings enter the house without obstruction.

In 1834, he made a further experiment on the ridge-and-furrow principle, in the construction of a greenhouse of considerable dimensions, adopting a still lighter sashbar than any previously used; on which account the house (although possessing all the advantages of wood) was as light as if constructed of metal.

In 1837, in constructing the great conservatory at Chatsworth, it was found desirable to contrive some means for abridging the manual labour required in making the immense number of sash-bars requisite. The only apparatus met with was a grooving machine, which was subsequently so improved as to make the sash-bar complete. For this apparatus the Society of Arts awarded Mr. Paxton a medal; and this machine is said to be the type from which all the sashbar machines now used are taken. The machine saved in expense 1400*l.* The length of each of the bars made by it is 48 inches, only one inch shorter than those of the Exhibition Building, therefore there was adequate experience as to the working of the sashbar machinery for the Exhibition Building.

The roof of the Exhibition Building is built on the ridge-and-furrow principle, and glazed with English sheet glass, the rafters being continued in uninterrupted lines the whole length of the building. The transept portion, although covered by a semicircular roof, is likewise on the angular principle. All the roof and upright sashes being made by machinery, are put together and glazed with great rapidity, for, being fitted and finished before they are brought to

the place, little more is required than to fix the finished materials in the positions intended for them. The length of sash-bar is stated by Mr. Paxton at 205 miles. The quantity of glass is about 900,000 feet, weighing 400 tons.

On each of the longitudinal wrought-iron framed girders is laid a gutter, and upon and communicating with this, four transverse gutters and plates, on which are laid the sashbars of the four ridge-and-furrow roofs and glazing. The water falling on the glass is carried to the transverse gutters in the furrows, thence to the longitudinal gutters on the girders, and so down the hollow columns of the building to the bases, whence it is carried off by 6-inch cast-iron water pipes.

The glass made use of is English crown, 50 inches long, 10 inches wide, and $\frac{1}{16}$-inch thick, running from the ridge-piece to the gutter-plate. The object of this length is to do away with overlaps.

The transverse trussed gutter-plates or troughs are cut out of solid fir-scantling by machinery before they are brought on to the building. These transverse gutter-plates are trussed with wrought-iron rods, bent in the form shown, which can be screwed up or slackened by nuts at the end.

Having explained the general construction, we shall now refer to our engravings. Fig. 1 is half-length of the transverse gutter-plate A, the whole length being 24 feet, width 5 inches, and depth 6 inches. On the lower part of the gutter-plate is seen the tension rod, *c*, 1 inch in diameter, secured by a nut and screw-plate at *a*, and passing through the eye of the queen bolts, *b*. It is particularly worthy of observation that the gutter-plates are made with a camber, so that the rainwater shall fall from the middle of the gutter to the ends, be readily carried off, and be precluded from lodging. The but-ends of the gutter-plates, as shown in fig. 2, are likewise brought together, and fixed in a cast-iron shoe, with an aperture to carry the water down into a square trough.

Figs. 2, 3, 4, and 5, are enlarged views of the gutter-plate, drawn to a scale of one-fourth the full size. Fig. 2 is a side view, showing the ends of the tension rods with the nut and screw, and cast-iron plate fixed to the underside of the gutter-plate, of which fig. 4 is a view of the underside, and fig. 5 a transverse section of the gutter, showing the end of the tension rod, and how the plate is fastened to the timber.

Fig. 3 is another transverse section of the gutter at *y*, *z*, and also of the skylight, showing the wooden bar of the skylight and the ridge. The ridge is worked by machinery out of solid deal 3 inches square, and the butting-joints have ½-inch dowel 3 inches long. The ordinary skylight-bars are 1½ inch deep by 1 inch wide, shown in the small section, with a ¼-inch groove on each side to receive the glass. The other small section shows the form of other intermediate-skylight bars called string-bars, which are 2½ inches wide by 1½ inch deep. It will be perceived by the section, that the skylight-bars frame into the ridge, and are notched on to the trough gutter, being secured at top and bottom by 3-inch nails. For the purpose of taking off any condensation forming within the building which may run down the glass, a groove is provided worked on each side of the gutters.

The skylights are 8 feet span, and have an incline of 2½ to 1.

Fig. 6 is a transverse view of one of the ridge-and-furrow skylights.

Figs. 7 and 8, elevations of the exterior, showing the two stories, the lower being closed with boarding, and the upper glazed. The base, to the height of 4 feet, is fitted with luffer boarding, with the view to ventilation.

If the several details be carefully examined, it will be discovered there are several contrivances to save labour and facilitate fixing. It will be interesting to observe, that in matters so common and so commonplace, there was yet room for the exercise of research and ingenuity.

THE BRIDGE FAILURE AT THE SOUTH-EASTERN STATION, LONDON BRIDGE.

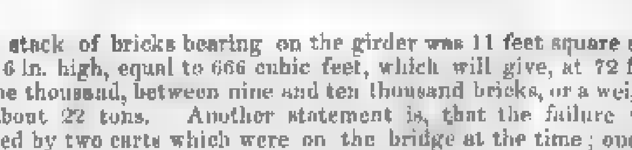
EXPERIENCE is only true and valuable so far as it is on an extended basis, for though called so, that is not experience which is merely local and partial. We are not always called upon to reproduce the same model or work on the same lines; but our practice is chiefly in the extension or particular application of existing examples. It therefore becomes of the greatest importance that we should have as wide a collection of facts as possible, so as to enable us more safely to calculate the result of any new direction, new application, or further extension; so, indeed, as to secure us from experimenting too far. We want, therefore, not only examples of success, but of failure; we want especially to know where any principle has been strained too much, that we may avoid such extreme, and where any detail has proved defective, so that we may apply the proper remedy. It has therefore always been considered, by our best authorities, as most expedient to record failures. Thus Smeaton prefaces the history of the Eddystone Lighthouse; thus, in the history of the Menai Bridge, the checks received in experimenting, by which the ultimate application was arrived at, are carefully set forth for the guidance of future practitioners. We have therefore felt it highly desirable to report, as accurately as it is possible, a few particulars as to the failure of the Bridge over Joiner-street, at the carriage entrance to the South-Eastern Railway Offices of the London Bridge Station, which took place on the 19th October last.

The bridge is of a peculiar construction, and consists of six compound girders of cast and wrought iron, patented by Captain Warren. The annexed engraving, fig. 1, shows part of one of the girders, rather more than half the length; and fig. 2, a transverse section of the roadway and two of the girders. There are in all six girders, placed 11 ft. 6 in. apart. The girder that broke is 41 ft. 6 in. long, and consists of a series of triplet cast-iron triangles, with a connecting-rib along the top and bolted at the joints, but there is no connecting-rib along the bottom of the girder; instead of which, they are held together by a horizontal tie, consisting in width of four wrought-iron bars, 6 inches deep by 1¼ inch thick and 13 feet in length, coupled together by 4½ inch bolts passing through a boss cast on the triangular stays, and also bolted to the intermediate triangles.

The cast-iron triangles are 4 feet deep, with a rib cast on the top 6 inches deep, making the whole height of the girder 4 ft. 6 in., and the length of the triplets 18 feet; the section of the cast-iron is T-shaped, 5½ inches wide on the back, and the depth the same; the thickness of metal 2 inches.

On the top of the girders are laid cast-iron plates, 11 ft. 6 in. long, with ribs bearing at each end on the girders; on these plates rest the materials which form the road, as shown in fig. 2. It must be observed, that the horizontal tie-bars are not intended to act as suspension bars; they are merely connected at the abutment piers to the ends of the cast-iron triangles. The points at which the bridge failed is marked with the letter *f*, where one of the cast-iron stays broke asunder, and also the top rib, as shown in fig. 3, which is an enlarged view of the triangle which failed. It was only 5 feet from the abutment. The fracture is shown at *f*, *f*, *f*.

Various statements have been made as to the cause of the failure. It was stated that the accident was caused by the girder being loaded with a large stack of bricks; but this is doubted, as the stack was at the opposite end, as shown in the annexed diagram.



The stack of bricks bearing on the girder was 11 feet square and 5 ft. 6 in. high, equal to 666 cubic feet, which will give, at 72 feet to the thousand, between nine and ten thousand bricks, or a weight of about 22 tons. Another statement is, that the failure was caused by two carts which were on the bridge at the time; one of them, loaded with bricks, it is supposed passed over some obstacle, and caused the wheel to descend suddenly with great force. Whether this be so or not, we cannot pretend to say; but if the bridge had been properly constructed, with a cast-iron girder 41 ft. 6 in. long, and of the great depth of 4 ft. 6 in., it ought not to have broken down with any such force. For ourselves, we are decidedly averse to these compound girders of wrought and cast iron. The contraction and expansion are unequal; and, consequently, the strain must be constantly varying, while the slightest deflection of the wrought-iron must cause the cast-iron to snap asunder.

If this bridge had been constructed with a series of triangles, cast with a connecting-rib at the bottom and a broad flange on the underside equal in weight to the wrought-iron, it would, in our opinion, have stood, and borne a weight far greater than this compound-girder bridge.

The broken rib having been made good, the bridge has been tested with a considerable weight, but with what success we have not been able to ascertain.

Figs. 1 and 2 are drawn to a scale of ⅜-inch to a foot, and fig. 3 to a scale of ¾-inch to a foot.

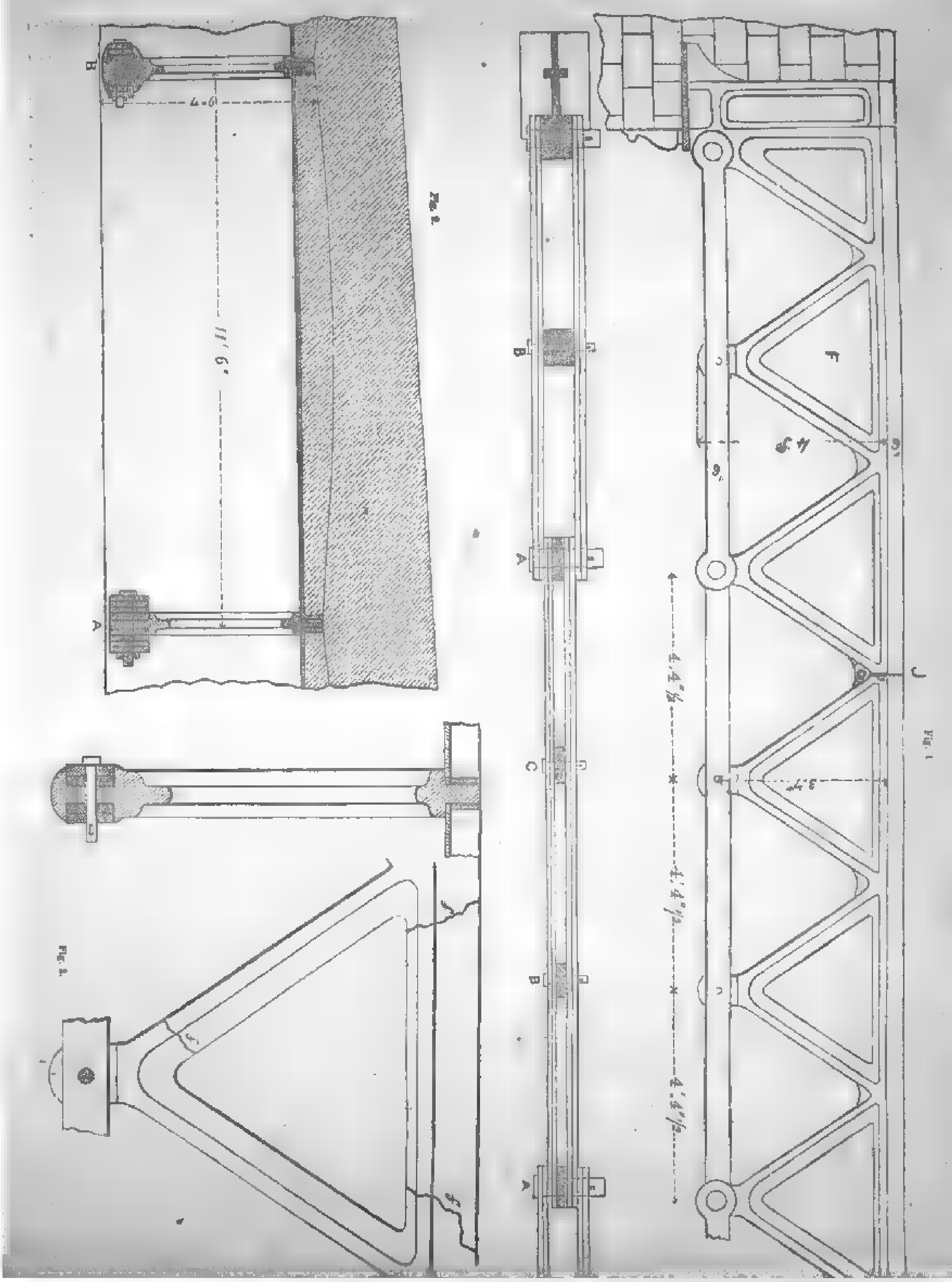


Fig. 1
Fig. 2
Fig. 3
11' 6"
4' 6"
4' 4½"
4' 4½"
4' 4½"
A
B
C
F
J

SHANNON IRON BRIDGE—GIGANTIC PILE DRIVING.

A most important fact is recorded in connection with the progress of the Midland Great Western Railway Bridge over the Shannon, in the sinking of cylinders of 10 feet in diameter for the foundations. This has been done with Potts's pneumatic process by Messrs. Fox and Henderson, the contractors, who have likewise, we believe, the working of the patent. We mentioned some time ago that these cylinders were in progress of construction, and looked forward with some interest to their application in practice.

In reviewing Mr. Edwin Clark's work on the Britannia Bridge, we had the opportunity of describing the large cylinders which are being put down by Mr. I. K. Brunel, on the Wye, for that remarkable structure which he is now carrying out. The sinking of those cylinders as there described is not in the nature of pile-driving, and although they are of a very large size, yet the 10 feet cast-iron cylinders of Messrs. Fox and Henderson are the largest ever applied in the nature of pile foundations, and on this account their success is of material interest to our readers.

The bridge is, we understand, of iron, and of large dimensions, and is supported entirely on cast-iron cylinders, of the diameter mentioned. The cylinders near the shore have been put down by excavating and the application of weight; but those in the bed of the river, by Potts's process. We need scarcely inform our readers that, in this simple process, an air-pump is employed, which being connected with the head of the hollow pile, the air is exhausted, and a stream of water, sand, shingle, and gravel, rushing up from below, the pile sinks gradually into the displacement made to any required depth. It is therefore a kind of sub-aquatic excavation, the lower end of the hollow pile being converted into a kind of scoop, worked by the air-pump on the platform above. The exhaustion employed was 26 inches of mercury, equivalent to 13 lb. to the square inch; and the cylinder was driven down between 5 and 6 feet in a few minutes, or rather suddenly, until checked by a piece of submerged or drifted wood. The operations were under the direction of Mr. J. Millner, C.E., the contractor's engineer; and the bridge abutments, which are of stone, under Mr. Dargan, the eminent Irish contractor. The cylinders will be filled-in with concrete.

Hitherto the piles employed for Potts's process for sea-beacons, for the Maeldraeth Viaduct, the Black Potts Bridge, and other structures, have been of very small diameter, so that the proceedings we have just described are of the greatest importance. A cylinder of 10 feet diameter gives a large bearing, and four such cylinders will carry a large tablier or platform for a pier, and which can be put down without cofferdams or other preparatory works, thereby greatly reducing the expense of submarine foundations. Here neither cofferdams, caissons, steam-engine pump, nor diving-bells are wanted, only an air-pump of adequate power, which can be easily carried about and rigged anywhere. It will be obvious that unless sunk from the inside (when there would be as much trouble for pumping as by the pneumatic process, and very much labour and expenditure of time), any external application of power would, if it could be employed, exercise a very unfavourable effect on the material of the cylinder. Indeed, a force of much less than 13lb. to the square inch would smash a hollow iron cylinder to pieces. Then again it is to be observed, that 10 feet is by no means the limit of the diameter to which the cylinders can be carried, so that it is open to engineers to design works in situations and under economical conditions where hitherto the resources of art were insufficient to meet the emergency.

IMPROVEMENTS AT GRANTON

Most extensive improvements have been carrying on, for a considerable time past, at Granton harbour, says the *Scotsman*, and a gratifying circumstance in relation to them lately took place. This was the launch of an iron dredging-machine for the deepening of the harbour, from the works of Messrs. S. and H. Morton, who have only recently commenced business at Granton, although well-known in connection with their extensive engineering establishment in Leith Walk.

The name given to the "dredger" is appropriate—namely, "The Howker."* It was designed by Mr. Walker of London, the chief engineer of the harbour, who was present and took an active share in the whole proceedings. It is about 90 feet long, and 22 feet wide, with a depth of hold of about 9 feet. The engine with which it is to be fitted up will be about 20-horse power; and it is calculated, we understand, that the dredger will work to the depth of 20 feet from the surface of the water. It is expected to be completed, and in full operation, in the course of a few weeks; and the first work to which it will be set will be to make the inner berth along the pier equal in depth to the outer one, which is from 10 to 12 feet at low water of an ordinary spring tide. Already three barges have arrived at Granton, to work in conjunction with the howker. These are built of wood, and upon the "hopper" principle, by which they are enabled to discharge their cargoes almost instantaneously in deep water. Two other barges, made of iron, are to be built by the Messrs. Morton, and when these are finished, Granton may with truth be said to have a most thoroughly equipped dredging establishment.

Various improvements are going on at Granton of considerable magnitude and importance; in addition to the noble pier that has been completed some time, it is the intention of the noble proprietor, the Duke of Buccleuch, to erect a breakwater on the east side of the pier and another on the west, so as to inclose a spacious harbour on each side. The area is about 77 imperial acres in extent, and that of the eastern about 52. The breakwaters, like two arms, will surround these harbours, with the exception of a space of about 70 yards a little to the north of the point of the pier, which is to serve as an entrance for the shipping. The breakwater on the western side, which is to be upwards of 1000 yards in length, has been in progress of construction for a considerable time, and is all finished except about a hundred yards. The eastern breakwater has not yet been commenced, but arrangements are under consideration for its being speedily undertaken. The height of the western breakwater is about seven feet above high water, so that, even as it at present stands, it will form a pretty good protection for vessels in westerly and north-westerly winds; but when it is surmounted, as it is designed to be, by a parapet wall, the protection will be effectual from winds blowing from either of these directions. In fact, when the eastern breakwater is finished, as it is to be, in the same manner as the western one, Granton will almost be one of the safest places in the Frith of Forth during a storm. These improvements will add very much to the value of that rising port.

It is his grace's purpose to lay down, without delay, a patent slip, of great magnitude, for the benefit of all the large shipping coming to this part of the country. This slip, which will be on the principle of Morton's patent, will be the largest in the kingdom, with the exception of one at Belfast. It will be sufficient to allow vessels of 1000 or 1200 tons to be taken upon it for the purpose of being repaired.

* *Howker* is a Scotch phrase for "digger."

THE WATER SUPPLY OF LONDON.

Report on the Water Supply of London. By the Hon. William Napier.—(Presented to the General Board of Health, Gwyder House, Whitehall.)

Part No. I.

Farnham, Surrey, Oct. 2, 1850.

My Lords and Gentlemen,—Having had the pleasure of receiving in August last your instructions to visit the gathering grounds of the proposed water supply to the metropolis, in order to gauge the streams and make a careful re-examination of the general capabilities of the country for the purpose intended, I have now the honour to submit to your notice the results of my observations, with a few remarks on the different bearings of the scheme.

On reading the Board's report presented to the Houses of Parliament during the past session, I perceived that from the very short time at the disposal of the Board the calculation of the quantity of water available from the rain-fall on the district, an extent of nearly 150 square miles, was necessarily founded on the discharge of the streams at their outfall.

The Board were thus also manifestly placed under great disadvantage when endeavouring to ascertain the character of these waters; for, as such waters inevitably partake of the nature of the soils through which they have passed, and as the pure sands of the district are not only bounded by clay on the north-east, east, and south-east, by chalk on the west, but are also intersected from east to west in the south by a high range of chalk hills, the course and outfall of these streams present certainly a widely misleading test of the quality of the water to be derived from pure sands.

Considering the purity and softness of the supply to have the first claim upon my attention, I remembered the principle enunciated by the Board, "the nearer the source the better the quality," and made it my first object to examine the nature of the soils in which the rain-fall of the country makes its appearance after percolating through the upper crust, and next, the soils through which it passes to its outfall.

The water-supply of Farnham being derived from the hill on the south side of which the village stands, I bent my first steps thither, not only to examine its source, as likely to present indications for purity to be looked for elsewhere, but also to have a good bird's-eye view of the whole area under investigation. The position of the hill in the south-west, its elevation of nearly 700 feet above the level of the sea, and 300 feet above the plains beneath, admirably adapted it to this purpose. It was then only I discovered that the Farnham water does not come from the surface drainage, but is derived from sixteen small springs, issuing at the south side, on a contour, so to say, about 30 feet above the highest level of the hill. From the contracted area out of which so large a supply is gained, I was induced to suspect that these springs are not due to the rain-fall on the ground above them. I was further led to this consideration by observing that, from the slope of the ground, and from the almost impenetrable hardness of the superficial covering of gravel, the rain-fall could scarcely find its way through this surface. A violent storm having most opportunely come on whilst speculating over this probability, I perceived that the whole of the water apparently ran rapidly down the hill-sides and was speedily out of sight, leaving the surface perfectly dry, except where irregularities retained a few pools, which subsequent observation proved to me were exhausted by evaporation rather than by percolation. I then examined the north side, and found that on the same contour a still greater indication of springs existed. This satisfied me that these waters are due chiefly to rain-fall elsewhere; for a rough calculation of the yield of the springs much exceeded the available rain-fall on the area within the contour.

Convinced of this, I naturally concluded that, if the other ranges of the district were of like geological formation, they would in all probability present similar appearances about the same level; a most desirable source for the streams of the country, the advantage of which, in addition to the proposed drainage supply, could hardly be over-estimated. The first week of my researches was confined, therefore, to the nature of the soil throughout the district, presenting generally a vast depth of pure sands, obscured in the higher levels by extensive patches of gravel from 2 to 20 feet in depth; in the lower, by a poor loam, from one to three feet deep. Patches of peat, here and there in spots of some depth, exist principally in the lower levels. On the west and south-west the loam has a subsoil of very stiff clay, apparently of the London formation, which also crops out on the north side of Farnham-hill. On the north and north-west, in the valleys, there exists within a small area a considerable quantity of iron in some of the peaty bogs. All these are marked upon the plan which I shall hereafter have the honour to lay before the Board, and which I have prepared as accurately as the shortness of time allowed.

The next object of my research was the quality and quantity of the water. The Board, in their report, have given the quantity now brought into London by the different water companies as a stream 8 feet wide and 3 feet deep, flowing with a velocity of two miles an hour; a supply double the actual consumption. In the course of my exploration I could not fail to observe that such a volume of water of any quality was nowhere to be seen, which at first rather damped my hopes for the future; but I remembered that such a body might be made up by collecting the smallest threads of rivulets, and went on my way. To effect this then was my object.

A most minute inspection of the gathering grounds has shown me that their nature exactly adapts them for the means of collection proposed by the Board, namely, a system of thorough drainage. A more admirable plan of gathering rain-fall could not have been conceived; the sands, acting as a natural filter, deprive the water on its passage to the pipes of any impurity contracted either in the air or in percolating through the upper crust; as, for instance, where the water might be discoloured by peat, experiments have proved that the sands restore its primitive colour, and deprive it also of the flavour imparted by the peat. The heath, which covers the entire area of the gathering-grounds, also stains the water, but the impurity is removed by this process of natural filtration. I would remark, that the discolouration visible in the stream called the Blackwater, is not caused by peat, but by the heath and loose black loamy nature of the soil through which it flows. This I have proved, by following up its various sources, one of which only, at Cove, passes over peat. Samples of springs rising in peaty bogs, show no discolouration whatever, but are as clear as water issuing from sands.

Remembering Farnham-hill, I turned my attention to look for springs, and, after much and close examination, came to the conclusion that the origin of many little silver threads of water, silently stealing down the hill sides under the grass, arose also from such sources. A diligent search showed me that the quantity of water to be derived in this manner within the original area of the gathering-grounds is so great, that if the neighbouring ranges of mountains and hills on the south side—namely, Hindhead, Blackdown, Hascombe-hills, Leith-hill, &c., presented the same feature, I might probably hope to collect a stream 9 feet wide and 3 feet deep, of the desired softness and purity.

I am now happy to inform the Board, that a month's researches into every hill and glen, every copse and crevice, has produced this result. Having tested the waters as they issue from their sources, I can announce that I have gauged a sufficient number of springs and rivulets to enable me to form an opinion both as to quantity and quality; the water being of its primitive purity, perfect as to aëration, brilliant in colour, soft almost as distilled water, of a grateful temperature, about 50°, and almost free from all mineral, animal, and vegetable impregnation. In a future section of this report, I hope to be able to give the Board more extended information on this point, as also with reference to the levels of the springs above mean tide. Thus, by gauging and testing the streams at their sources, instead of in their course and outfalls, we have the realisation of the principle laid down by the Board; and this difference will account for the variance of my results with those of Dr. Angus Smith.

The annexed table of springs and rivulets gives their hardness, according to Dr. Clarke's soap test, their daily discharge, and the number of houses they are equivalent to at 75 gallons per house; an addition of one-half the average domestic consumption, as proved by an experiment instituted in the district of Earl-street, London, on a block of 1200 houses of a fair average class, the gaugings of the sewer gave 44½ gallons, and of the butts and cisterns, 51½ gallons per house.

Table *of Springs and Rivulets, showing their hardness, daily discharge, and the number of houses each is equivalent to, at the rate of 75 gallons per house.*

Names.	Degrees of Hardness.	Gallons discharged per day.	Houses at 75 gallons per house.
Hindhead and Blackdown [1] :—			
Holy-water	2	1,350,000	18,000
Bramshot [2]	1½	13,399,714	178,663
Down-lands	1	540,000	7,200
Headley-down	1	239,731	3,197
Barford-mills	1	2,880,000	38,400
Devil's-jumps	2	[illegible]	15,000
Punchbowl	½	299,905	3,999
Cosford-house	1	674,924	8,999
Gray's-wood	½	84,240	1,123
Kotchet	1	32,560	434
Five other springs	1	127,542	1,700
Hascombe-hills [3] :—			
Sweetwater-pond..	1	1,066,795	14,228
Rush-bridge	2	529,200	7,056
Chapel-copse	2	224,097	2,988
Hascombe	2	299,114	3,988
Leith-hills [4] :—			
Tottsford	2	1,799,784	23,997
Wotton	2	890,956	11,879
Rookery	2	1,436,400	19,152
Easthampstead Plain :—			
Wishmoor	1	388,308	5,177
Broad-moor	1	176,040	2,347
Sandhurst	1	54,000	720
Amberrow-hill	1	75,888	1,011
Barkham	1	101,088	1,347
Wokingham	1	599,904	7,998
Bull-brook..	1	113,320	1,497
Chobham-ridges :—			
Pirbright	1	810,000	10,800
Railway	1	460,800	6,144
Cow-moor	1	90,432	1,205
Coldingley	1	758,100	10,108
Polly	1	256,425	3,419
Bagshot	1	630,000	8,400
Bristow-farm	1	14,999	199
Farnham :—			
Aqueduct	1	43,848	584
Minley	1	134,925	1,799
Northfleet	1	6,426,000	85,680
Longbottom	1	31,800	424
Bramshill	½	43,272	577
Eversley	½	74,779	997
Castle-bottom	1	270,000	3,600
North :—			
Farnham-hill	½	659,454	8,789
Total............	..	39,407,324	525,156

[1] Will be led away at one degree of hardness.

[2] One and a-half degrees under the mill-wheel; but will probably be led away at half a degree of hardness.

[3] Will be taken away at half a degree of hardness.

[4] Will be led away at one degree of hardness.

Giving altogether 39½ millions of gallons, which might be brought to London at a hardness certainly not exceeding one degree. I can answer for at least 10 millions more under two degrees of hardness. I must remark, that though these gaugings are only offered as an approximation, I consider they will eventually prove to be rather under than over-stated.

I would remark that, where the springs flow into ponds dammed up for the use of mills, I have taken the samples for tests from the springs themselves, as the evaporation alone of large surfaces of water generally adds two and upwards degrees of hardness, and the waters are also exposed to deterioration in colour, and, as I have found, in taste. For instance, at Minley Pond, itself situated between sand-hills, the springs do not show half a degree of hardness, the pond one and a half; at Sweetwater Pond the springs have half a degree of hardness, the pond two degrees; at Rush-bridge the springs have one degree of hardness, the pond nearly six.

I would here remark, that an erroneous opinion seems to prevail generally that large bodies of water should be examined for test of quality, which, in proportion to their size alone, show a scale of hardness contracted in their passage through loamy or other soils. Hitherto the little springs rising in pure sands, scarcely seen under the herbage, have been almost entirely disregarded, although when gathered together they form a volume equal in extent to that collected on the lower levels, and of a purity and softness in no case to be found there.

The gaugings of these springs having been taken at the end of a drought of nearly five weeks, and at the close of an average dry summer, I conceive they are to be relied on with safety, as being at their usual summer ebb. Being a perfect stranger to the district, and of course obliged to depend very much on the testimony of the residents as to the flow of the springs, I have addressed myself to persons of all classes, gentry, farmers, and labourers, many of whom have resided all their lives on the same spot, and are therefore well able to offer an opinion. I received much valuable information from an herb doctor, who devotes his sole attention to wounds and sores, and finds his remedies in herbs and grasses, many of which grow in water, by which means he had come to the knowledge of these springs. The unanimous opinion of all observing persons is, that I gauged these springs at their lowest. I am convinced that the greater mass of them are, as at Farnham-hill, due to rain-fall elsewhere, probably on ranges of equal and higher levels, at a considerable distance, where the nature of the strata will not permit of the rain-fall making its appearance again after percolation; the water then finds its level, and an easy channel through the sands of the gathering grounds. I attribute the fact of the springs invariably coming out under the highest and steepest bank of the hills to the circumstance, that such is the only place where on that contour there is not the usual densely-packed covering of gravel, through which they would scarcely penetrate when there is an easier outlet. The steepness of the bank itself is apparently caused by the undermining action of the springs.

My opinion of the unfailing yield of these springs is confirmed by the peasants, who in several instances have of their own accord informed me that at the close of autumn, generally in October, when there has been no rain in this district, the springs commence rising just after a high wind. They offer no explanation of this apparently extraordinary circumstance, which to me, however, admits of easy explanation; the high wind being possibly a fortuitous circumstance, but probably indicating a storm of rain and wind elsewhere, where the strata are of the formation alluded to.

Droughts of much longer duration than five weeks seldom occur, and, should they do so, the yield of the springs is so far in excess of the present requirements of the metropolis, that there is little foundation for any apprehension of scarcity.

To detect the presence of these springs in combination with other waters was in some cases very easy, as where the residents are acquainted with them, or where they are so large as to thrust themselves on one's view; but often they have nearly eluded my most vigilant scrutiny. Situated in the hollows of the hills, generally collections of rainwater are to be found, girt sometimes by dense copses with rushes and long-tangled grass. The marshy appearance of the ground on the lower side might, by a casual observer, be taken for the soakage of the pond; but if a trench be dug to the outfall the run is found to be constant, proving the presence of springs flowing into or rising in the ponds themselves. On one occasion, on questioning an intelligent labourer, he remarked that, when bathing in Minley-pond, he found the water at some parts much colder than others, and was at a loss to account for the circumstance, which clearly indicated the position of the springs, as I found the outfall to exceed the flow into the pond.

So secluded are some of these sources, that their existence on one occasion, at Chapel-copse, only became known to a *soi-disant* gamekeeper (but, from his appearance, I fear, a poacher occasionally), by the flight of game to drink there after dawn. This spring yields 224,697 gallons per day, equal to the supply of 2005 houses, and forms one of the many threads contributing to the desired supply. I am further of opinion, in which I am confirmed by all the residents, that these springs will, when opened—that is, given a free passage to the surface, often be doubled in volume; indeed, this has, on several occasions, been proved to be the case by paper manufacturers and others who have been anxious to increase their supply; as, for instance, at Barford Mills, where some years ago the paper-mill could only work for three or four hours a-day, but the spring having been opened now affords a sufficient supply for six hours' work. I have tested these waters, and all others in the district, including wells, and those from the surface, at different stages, as where joined by fresh tributaries, or entering a new soil, from their outfall to their sources, and the result has been very decisive in confirming the remark made by Professor Way, in his able paper on *The Power of Soils to absorb Manure*, 'that ordinary soils consist of three substances, sand, clay, and vegetable matter, but that very generally a fourth may be added, carbonate of lime.' When these springs rise in any other than pure sands, the water at once becomes hard to five or six degrees. If in any case I believed a stream to have a very pure source, I proceeded up its course, examining it at the junction of each tributary, and have never failed in discovering at length, and generally from the highest source, the thread of soft and sweet water to be added to the growing stream for water supply.

Let me point out the following, for example,—

	Degrees.
The Wey, at Guildford, which has a hardness of ..	9
At Elstead	8
Below the junction of the Bramshot river	8
Above the junction of the Farnham branch	6
Above the junction on the Bramshot branch ..	14
At Farnham	15
But turning up the Bramshot river at Headley Wood ..	5
At Bramshot	1¼
At Shotter Mill	¾

The above shows what different results two persons making the same investigations might arrive at. From Headley-wood to Bramshot is scarcely more than two miles; persons unintentionally, or for want of accurate investigation, might consider the water at Headley-wood the sample of greatest purity to be found, and go away with and disseminate a totally false impression. I have reason to believe it will be generally found that the opponents to the Board's proposition have, from one cause or the other, made this great mistake.

The power of soils in hardening water is particularly evident when comparing the water in a large pond to that in a well, which becomes hard almost in proportion to its depth. A notable instance occurs at Tomlin's Pond, a collection of rain water with a few small springs in it, which has a hardness of only 2 degrees; whereas, a well sunk close by for the convenience of some cottagers has a hardness of 5½ degrees. Again, Minley Pond has a hardness of only 1½ degrees, while a well, sunk through the loam into the pure sand, has 3 degrees of hardness.

The following is a list of well and surface waters, with their degrees of hardness:—

Wells.

	Degrees.
Hartford-bridge Flats, 25 feet deep	4½
Ash-common, 80 feet deep	6¾
Pirbright-common, 20 feet deep	5
Chobham Well	5
Swinley-cottage, Easthampstead-plain	5½

Surface Waters.

Ash-Common	3½
Holt-pond	2¾
Dippenhall	3½
Whitemoor	3½
Aldershot	1½
Canal, Reading-road bridge	5½

Thus we see that waters stand for purity in this district in the following order:—1. Springs issuing from pure sands.—2. Collections of rain water. —3. Water running through ordinary loamy soils.—4. Well waters.

How great is the loss of capital and labour expended on wells, which when made, what has been done? A vast expense is incurred to dig a hole in the ground to allow water to soak into impure from the mineral qualities of the soil; what water?—that which fell originally soft and pure, and which might have been collected on roofs, or by drainage of cultivated lands and led into a covered reservoir, and thence to the highest room in the house. One gentleman with whom I am acquainted spent from 300*l.* to 400*l.* in sinking a well 300 feet deep, whence he obtained water of a hardness equal to that of London. 400*l.* would have drained from 40 to 50 acres of his land and paid for a covered reservoir, besides saving the labour of pumping and carrying, the waste of the latter in the case of using 76 gallons per day per house, amounting to a loss of three days' labour of one person in a week. The improvement of the land drained would alone have repaid the outlay.

A great economy in having water laid on to the top of a house exists from the indolent propensities of servants. Should there be two supplies, one of soft water, and another of hard nearer the premises, the servants will, I have frequently found, to save trouble, use the latter for all purposes, thus extravagantly wasting their masters' tea and soap; the saving in the consumption of which with soft water would soon have paid the cost of laying pipes into every part of the house.

I would point out the defects of storage reservoirs on gathering grounds as now existing in some parts of this country. They collect the crude surface waters, always liable to discolouration and thickening from dirt brought in by heavy rains, to deterioration in taste, to hardness from contact with the soil, as also by evaporation; this last, however, being trifling as compared with the first, as we have already shown. Compare these results with the proposition of the Board. After the ground is once saturated, the rain-fall passes immediately through a natural filter of sand into the drainage pipes, which lead it away to storage reservoirs lined with tiles to prevent the water acquiring the mineral qualities of the soil, hence to a covered reservoir in the neighbourhood of its distribution, safe from the noxious influence of the impure atmosphere of a city. The importance of covered reservoirs cannot be overrated when the evidence given by several eminent professors of chymistry before the Board is considered, although little more than every day's experience is needed to show that what is disagreeable on a small scale must be very detrimental, often dangerous, in larger volumes of water. A tumbler of water cannot be exposed half an hour without becoming warm, vapid,

and badly tasted; and from what cause? Simply because water has an extraordinary capacity for absorbing the impurities of the atmosphere.

Referring again to the plan of collecting rain-fall by draining the sandy heaths, I question whether it could in one case be carried out with advantage—namely, on the higher levels; as, for instance, the crests of the Fox Hills and Chobham Ridges, where the strata of sand are of a very loose nature. I think that the surface once broken through, the water would pass by the pipes. The area on which this would happen is, however, not very large. It is very desirable to ascertain this point by trial works; a few acres drained would satisfactorily settle an important question. The same would occur in the lower levels were it not that nature has abundantly provided a subsoil in the form of a crust or pan about 9 inches thick, composed of 3 inches of closely-packed pebbles and sand resting upon 6 inches of sandstone. This pan lies at a depth varying from 1 to 3 feet below the surface; in some cases it is found beneath a few inches of sandy loam. The pipes might be laid on the pebbles and sand incrusted together, which would hold the water. The pan once broken through the water would, I fear, be lost for ever. The cultivation of these heaths would eventually repay a large portion of the expense of collecting a rain-fall by drainage. Mr. Hewett, a most intelligent farmer and land surveyor, from whom I have obtained much valuable information, assures me that where this pan comes near enough to the surface to be broken through, which is done at an expense of 8*l.* or 10*l.* per acre, and when properly manured, the cultivation pays.

The only disadvantage attending the Board's scheme, if in such an important matter it may be deemed so, is the expense of the large lined storage reservoirs necessary to contain a six weeks' or two months' supply for a city of the giant proportions of London; otherwise the system is unique in simplicity and perfect adaptation for the purpose required. So vivid was this impression on my mind, that on developing the idea of supply from springs, I conceived a method of adapting the principle to my own case. Where the springs are large, I propose to inclose them in brick or tiles, but when small and numerous I would prefer to gather them in one stream to be led away in pipes; but this must be effected on the pure sand, and great care must be taken to avoid the mixture of surface-washing. In the case when leading away a stream of springs it would be liable to discoloration from heavy rains, I propose to provide a remedy by preparing at the point of diversion from the natural channel a new bed for a short distance at a less inclination. The bed to be a trench with a pipe at the bottom, and filled up with small stones and sand, heather or heath being placed round the pipe joints. The stream being led on this new bed will percolate into the pipe beneath. When the extent of the ground above the springs would expose them to be choked up by rubbish and dirt after a storm, I would intercept the rain-fall in contour trenches with pipes underneath them also, and lay a branch to lead the water away to the main. I have shown both these plans as adapted to the case of Farnham-hill, and a large addition might thus be made to the flow of the springs if desirable.

Hereafter I propose to detail my arrangements of branch lines from the spring-heads, leading to mains terminating on Wimbledon-common; giving also an estimate of the expense of the entire schemeworks, compensation to mills, &c., also some general information on the collateral advantages of a pure soft water supply—the results of some experiments I am making on the action of sand as a filter, and some qualitative analyses of the springs.

The annexed plan is that of Farnham-hill, reduced from the Tithe Commission plan, and tested as to accuracy. The blue contour line represents the level of the springs. I have gathered them together and gauged their flow as accurately as in my power. Their daily discharge is equal to 897,393 gallons.

The area within the contour line is 571 acres. The available rain-fall from 22·65 inches per annum; a mean of 30 years' register at the Military College, Sandhurst, allowing the usual deduction of 14 inches for evaporation and absorption, is 279,838 gallons per day. The difference, then, 611,160 gallons, is the least figure in favour of my assertion that the water in this hill is due to rain-fall elsewhere, for the rain on the hill does not percolate, but passes away.

I assure the Board, however, that a careful collection of these springs would double their volume, and produce a daily discharge of 1,794,786 gallons. This, then, leaves a total of 1,514,928 gallons above the available rain-fall on the hill, supposing it all to penetrate. The plan also shows the hill drained above the springs on the principle already alluded to. The section of the pipes and their outfall is calculated in proportion to the quantity of rain likely to fall in the shortest time, according to the principle laid down by Mr. Chadwick.

In reference to my idea of the cause to which these springs are due, I would mention that a notable instance of the kind occurs in Hongkong, an island mountain of not 25 miles in circumference at its base, and of 1000 or 12,000 feet elevation above the level of the sea. The quantity of water supplied from springs on the top of this mountain is notoriously far beyond its rain-fall, which latter, from the declivity of the other ground, is at once discharged into the sea, as all who have been there are well aware of. The shore of the mainland is not farther than two miles and a-half, but the range of mountains of equal and higher elevation, and which furnish the supply, are at a distance of upwards of ten miles. The rain-fall cannot find its way again after percolation to the surface, and is necessitated to find its level by crossing the sea and rising through the fissures of the granite formation of Hongkong. The springs are rarely known to be affected in quantity even after a three months' drought in the island, the thermometer often at 80° and upwards in the shade.

The advantages I propose to derive from permanent springs, that is, always preserving an average flow of summer and winter, over surface drainage, are twofold:—

1. The continuous flow from springs gives water of better quality as to aëration and temperature.

2. An immense saving will be effected on the item of storage reservoirs, and, I believe, a considerable sum in the diminished quantity of excavation and pipage. Assuming that the supplies from these springs do not materially alter, no necessity can exist for storage reservoirs. A covered reservoir for two days' supply might be provided at Wimbledon-common to meet any extraordinary emergency; otherwise, a main with a simple waste-pipe into the Thames would suffice.

Too much importance cannot be attached to a constant flow of pure, cool, and soft water, brought direct without detention from the fillodhead to the attic of the highest house in London. How grateful will be the daily use of cool soft water only 24 hours from a natural reservoir in the depth of the earth!

I consider I have realised, in a remarkable manner, the Board's enunciation—"The nearer the source the purer the supply." The whole value of the scheme appears to me to depend on the accurate following-up of this principle.

On consideration of the original proposal, there is only one more point I shall at present touch upon—namely, the great and scarcely estimable benefits of land drainage, not only to the soil, but to the inhabitants of the district. From the rain-fall, a depth in the year of 22·64 inches (allowing seven to be absorbed), there remains nearly 15 inches, or 1529 tons of water on every acre, impeding cultivation by diminishing the temperature of the soil, by not allowing a proper circulation of air in it, and by causing a perpetual evaporation, not only injurious to health in itself, but excessively wasteful of the heat of the atmosphere, a loss which in our damp climate is a very serious consideration indeed; and it is only when the whole country shall have been perfectly drained that this stigma of unnecessary and dangerous damp will be effaced from our registers of temperature.

Again, experience has satisfactorily shown (*vide* the Report on the Water Supply) that the low temperature of undrained land is the chief cause of scanty and poor crops, and inferior growth of timber. In an economical point of view, it is most necessary then to remove this noxious agency.

Having given the results of my observations in detail, it may be now proper that I should state my opinion of their variance as compared with the conclusions enumerated in the report, which difference I attribute to the limited investigation of the subject.

Generally, in all points as applied to the quality of water, its advantages in economy, its beneficial influence on health, &c., my experience not only distinctly confirms the views of the Board, but has elicited further illustrations, in respect to which I hope shortly to have the honour of addressing them. This information I have collected from persons of all classes, medical men, manufacturers, farmers, tradesmen, peasants, &c., all of whom, in their different spheres, have given me valuable evidence on the subject in question.

The results of my experience are as follows:—

I. With respect to the quantity and quality of water to be derived from the gathering-grounds, in whatever method of collection—the report gives 28,000,000 of and under three degrees of hardness. My results give 40,000,000 of and under one degree, and 10,000,000 of and under two degrees of hardness. This improved quality is gained by my development of the principle of taking the water from its source (that is, where it issues from pure sands), and leading it away before it can be affected by contact with soils. I beg to express my conviction that the purity will depend entirely on the careful execution of the work; it would give, to recapitulate its qualities, 40,000,000 of water, of primitive purity; perfect as to aëration; of a grateful temperature, about 50 degrees; brilliant in colour; soft almost as distilled water; and almost free from all mineral, animal, and vegetable impregnation, sufficing for the supply, at the estimate of 75 gallons per house, of 523,156 houses.—The 10,000,000 of and under two degrees of hardness are derivable from sources rising in sands not quite pure.

II. By the direct means of collection from springs, instead of the extensive system of land drainage originally contemplated, very considerable saving of expense would be effected:—1. In the less quantity of pipage required, and, consequently, of labour expended. 2. On the item of the large extent of storage reservoirs, originally required to provide for summer months, periods of drought; and which, by my plan, would be unnecessary. 3. On the reduced claims for compensation, especially as no breadth of land would be required to be taken up. In fact, after collection, on descending into the lower levels, the mains would lead along and just outside the lines of railway. A mere underground right of way—a pipe-laying easement—would be required.

A *résumé* of the above then gives, in favour of the plan proposed—1. Greater certainty of supply. 2. Superior quality. 3. Greater abundance. 4. Greater speed of execution of work and application for service. 5. Greater economy.

Should the future exigencies of the metropolis require an increased supply, it may still be derived not only from land drainage of rain-fall on the pure sands beneath the level of the sources now proposed, but also to a great extent above them.

In conclusion, I would remark that it might be considered desirable to allow the towns of Guildford, Richmond, &c., and the different villages on the line of water supply to London, to partake of the advantages proposed for that city. The first of these suffers severely from hard and expensive water. Of course they would have to pay their proportion of the rate to be levied to meet the expense of the works, which I hope shortly to be able to show will not, for an increased, continuous, pure supply of soft water, at high pressure, exceed a fraction of the sum now levied by the water companies for an impure, hard, and defective one.

I have the honour to be, my Lords and Gentlemen,

Yours obediently.

WILLIAM NAPIER.

The General Board of Health, Gwydyr-house, Whitehall.

IMPROVEMENT OF THE TOWN OF LIVERPOOL.

IN June last, the council advertised for plans for the improvement of the streets and approaches of the town, and the laying out of the unoccupied lands in its immediate vicinity, offering a premium of 50*l.* for the best one, and 25*l.* for the second in point of merit. By the end of August, twenty-three plans, with explanations, were sent in, all of which are now on view in the Council Chamber. The first premium was awarded to Mr. H. P. Horner, who adopted the motto of "Rus in Urbe," and the second to Mr. Henderson, "Curator." Both gentlemen are architects practising in that town. The suggestions and plans were submitted at the last meeting of the council.

Mr. Horner's Plans.

"In submitting the suggestions indicated on the accompanying plans, I should wish, in explanation of what may at first sight appear the rather sweeping character of some of them, to mention the general idea under which they were laid down, viz., that taking the terms of the requisition in their fullest sense, I should endeavour to form such a plan as would serve for my own guidance, supposing myself responsible for the *progressive* improvement of the town and its environs to the greatest extent which circumstances might successively permit.

"Such a plan, prepared with the most mature study, and revised from time to time, should, in my opinion, be kept by every public officer under such responsibility with respect to any large town, in order that the conclusions as to what would be desirable, when possible, might not be lost sight of, but, as leases fell in, buildings were removed, or land brought to sale, such opportunities might be seized for the improvement of thoroughfares, and such other alterations as would conduce to the convenience and comfort of the inhabitants.

"The general aspect of Liverpool presents several obvious points for the application of such a system of persisting improvement, as few large towns bear more distinct marks of having been laid out with little view to the probability of its increase, and in few have more opportunities been missed of correcting original errors at later periods of its progress.

"Among the most striking defects in these respects are to be observed the cutting off of leading thoroughfares at particular points, as if never to be extended, and sometimes closing them with a public building—a church and its burial ground for example—with perhaps a long cross street behind it, affording, for a great distance, no outlet in the direction of the main street.

"Again, we find that the districts to the extreme north and south have been laid out almost without reference to their connection with the centre, forming distinct systems of streets within themselves, with in each but one main connecting thoroughfare with the central part of the town, and that adopted only as following the tortuous course of an ancient roadway.

"Further, we may notice that the natural and easy method of gaining a summit by traversing its ascent in a diagonal line, has been lost sight of, and a steep rise breasted at a right angle, and at the same time communication made more difficult and tedious by series of streets traversing the length of the slope, with such frequent interruptions of line as to disfigure, and, to appearance, contract the extent of the town to an extraordinary degree. The crowning evil consists in the manner in which purchasers of land in the outskirts appear to been allowed to lay out their streets on any plan (or no plan) as might suit their own fancy and ignorance, causing irremediable confusion when the intervening space comes to be filled up, and increasing in a tenfold degree the almost necessary ugliness and discomfort attendant on the existence of that space of debateable ground between town and country which commonly surround an increasing and populous town.

"One or more of these considerations will be found to have led to the adoption of the several proposed alterations shown in my town-plan, in addition to the wish to open out some public buildings (now scarcely to be seen but on a close approach), and to give an increased number and length of vistas—points on which beauty and magnificence of effect in towns confessedly depend.

"As regards the approaches, my attention has been mainly directed to the connection of roadways at present detached, straightening those which are inconveniently crooked, providing for their probable communication with existing or proposed streets, and, above all, securing one of the best provisions for the *comfort and health* of an immense population, *a belt of garden or park land* bounding the present extent of the town, and insuring the interposition of a stretch of comparative *country* between the existing buildings and any more of a *town* character which may be needed in after times for the growing community.

"It is satisfactory to know that the corporation have of late years taken decided steps towards this last most necessary object, while the liberality of one generous man has set an excellent example in the same direction. Much, however, remains to be done, and it is with the hope of calling attention to the point that I have, so far as circumstances permitted me, shown how I think many tracts of, as yet, unoccupied land, may be made available for the use and recreation of all classes.

"The boulevards of Paris and other continental towns are acknowledged as greatly conducive to sanitary ends, and the subject, as is well known, has been taken up with much energy in London, where the feeling now prevails to secure for this purpose as much as may be of what land is still open; though the manner in which the town has been allowed to extend without this wholesome interruption throws great difficulties in the way, as will be the case in Liverpool, if speedy steps are not taken in the matter.

"The health of the population would, in addition, be benefitted by the opening up of lines of street terminating at the quays, and unobstructed by warehouses on the dock sides; and some such streets, crossing the rise of the hill *diagonally*, I have shown on my plan, and I do not know a point in which more has been lost to the good of the town, (through want of a better system of forming the streets,) than this important one of ventilation by long vistas from the river.

"Before referring *seriatim* to the several projects included in my scheme, I would observe that the legal powers required for such improvements can scarcely be less readily granted than for others of a more extensive and less benevolent character; while the difficulties which might be anticipated in gaining the co-operation of the large owners of land, involved in these changes, are to be met by the considerations of mutual benefit, which may safely be urged in their favour.

"The distinction between corporation and other property being scarcely traceable (in the plans furnished) even in the suburbs, and not at all within the town, the suggested alterations could not be guided by them, nor, it is presumed, was it expected that contributors of designs should enter into such particulars, as the labour and expense attending the necessary inquiry would have been such as to deter many from competing."

The report then details 22 suggestions for the improvements of the town, and for the formation or enlargement of eight parks in the environs.

"In conclusion, I would observe that, though the space of ground occupied by the proposed parks appears great, it must be remembered that their formation would necessarily be extended over a considerable period of time, and in our climate, and so near the sea, single rows or avenues of trees will never thrive in the same degree as shrubs and plantations will, which naturally shelter and protect each other from our cold winds.

"The strong probability that the town will eventually extend itself in length along the river rather than in breadth (crossing the natural boundary formed by the ridge to the east), has also led me to confine my proposal to this line of garden land as best suited to English tastes and habits.

"RUS IN URBE."

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

The first general meeting of the Institute, after the recess, was held on November 4th, at the rooms of the Institute, in Lower Grosvenor-street. In the absence of Earl de Grey, the president, the chair was taken by Mr. Fowler, one of the vice-presidents, who in congratulating the members upon their meeting together again, mentioned, in reference to the prospects of the ensuing session, the Great Exhibition of 1851—an event which could not fail to be of the greatest interest to the Institute of Architects. It would, doubtless, bring to this country a large number of the distinguished men of science abroad, the names of some of whom were enrolled in their lists as honorary and corresponding members; and the council had not forgotten to take into consideration arrangements to give their expected visitors a befitting and cordial reception.

Professor Donaldson, the corresponding secretary, in laying upon the table a collection of works presented to the Institute during the recess, likewise made a particular reference to 'Suggestions for the Improvement of the Lord Mayor's Show', by Mr. George Godwin. In alluding to useful communications, Professor Donaldson expressed his gratification that a French translation had been officially made of the paper read to the Institute last session by Mr. Henry Roberts upon "the Improvement of the Dwellings of the Labouring Poor." (*Des Habitations des Classes Ouvriers; traduit et publié par ordre du President de la République: Ministère de l'Agriculture et du Commerce.* 1850.) He dwelt upon this as a fact which proved the government of France was very prudently turning its attention to the sanitary and social condition of the working classes.

Mr. James Bell, Fellow of the Institute, read a paper "On the Remains of the Architecture of the Roman Provinces," which we have given in full at page 376.

INSTITUTION OF CIVIL ENGINEERS.

Nov. 12.—William Cubitt, Esq., President, in the Chair.

The following paper was read :—

A comparative view of the recorded Explosions in Coal Mines. By Mr. William West (of Leeds), Assoc. Inst. C.E.

The Reports of Faraday, Lyell, De la Beche, Playfair, and others, were carefully analysed and tabulated, from which it appeared that tendencies towards a dangerous condition existed in mines reputed to be comparatively safe, and that these tendencies were so numerous, and varied so suddenly in their nature and extent, as to necessitate attention to every kind of precaution.

The proposed appointment, by the government, of Inspectors of Mines, was noticed, not with the intention of showing that their supervision would diminish the responsibility of the mining engineers and overmen, but of demonstrating, that by establishing more constant communication between the various districts, they might induce the general adoption of those measures of precaution which were found in certain mines to be so efficacious in averting accidents, or in affording means of safety when they did occur.

The different depths of mines, varying from seventy-five yards at Darley, to three hundred yards at Haswell, did not appear to have any influence on the accidents. The tendency to the emission of carburetted hydrogen gas from certain seams, would have appeared a more rational reason, though the records did not appear to bear out that theory, as mines receiving a tolerable character, had been the scene of repeated explosions; for instance, the Jarrow Mine, where, although reported "to be not very fiery," there had been six explosions in the course of twenty-eight years, and one hundred and forty persons had been killed.

The compatibility of general good ventilation, with the occasional occurrence of the most fatal explosions, was particularly dwelt on. The witnesses on the inquests after the Haswell and the Jarrow accidents, agreed that the "ventilation was perfect," "the pit full of air," and "the air quite good, and plenty of it." The fault, then, did not lie in the quantity of air, but rather in the difficulty of directing it so generally throughout all parts of the mine, as to sweep away the gas as it was produced. The "splits," for the air were noticed, and the condition of the goaf, the packets of gas formed in the roof, and the sudden irruptions from the occasional falls in the goaf and old stalls, were dwelt on at great length, and, combined with the injudicious use of unprotected lights, and liability of accident to the lamps, were shown to have been the probable cause of all the explosions. The miners' lamps were passed over somewhat too cursorily, as at the present moment, when so much has been done for their improvement, that part of the subject might have been descanted on with advantage.

The precautions for saving life on the occurrence of accidents, such as abolishing bratticed shafts, and sinking a pair at each mine, at such distances apart as should ensure one remaining intact, in case of an explosion injuring the other; the "scaling off" of a portion of the fresh air for the exhausting furnace, and conducting the return air into the upcast shaft at some height above the fire; together with several minor details for insuring the constant working of the exhausting apparatus, to draw off the fatal "after-damp, or choke-damp," were strongly insisted on.

The rashness and carelessness of the miners was instanced on with regret; but it was shown that by education and good example, their better qualities must be brought out, and that then, the best safeguard against accident would be the instinctive love of life, and a knowledge of impending danger from the infringement of any of the precautionary regulations established in the mines. The improvement of the workmen was, therefore, strongly insisted on, as more real benefit would probably result from such measures, than from the appointment of a host of government inspectors.

The paper was illustrated by large diagrams of the author's views of the forms of "goaf hollows" and "goaf basons," as well as by several plans of mines, &c.

The President reminded those gentlemen who had recently joined the Institution, of the engagement they had entered into, to present original communications, or drawings, &c., and urged upon the members of all classes the necessity of furnishing good papers, so that the interest of the meetings might be sustained, and the usual discussions be promoted.

Nov. 19.—William Cubitt, Esq., President, in the Chair.

The subject of the paper read was "*The Ventilation of Collieries, theoretically and practically considered.*" By William Price Struve, (of Swansea), M. Inst. C.E.

The author commenced by showing that the general principles which ought to govern the ventilation of collieries, were—

1st. That a current of air through the channels of collieries, at a velocity of five feet per second, was sufficient for most purposes.

2nd. That a current exceeding that velocity would only be attained at the expense of leakage and other evils.

3rd. That in order to obtain the requisite supply of fresh air, the channels of a colliery or mine ought to be enlarged, according to the exigency.

In the process of laying out a mine, a subdivision occurred by which the workings were apportioned into numerous compartments, which facilitated the system of splitting the current of air, or diverting it into numerous channels, giving to each compartment a separate, and, therefore, more effective ventilating force; at the same time the area of the channel was enlarged, and the aggregate length of the air tube shortened, so that it was quite practicable to pass through the workings of a mine 300 cubic feet of air per minute for each man employed.

The velocity of the air current in a mine was so easily affected, that it was important to consider by what accidents, and under what circumstances, any changes took place.

It could not be supposed that the excavated space of old workings was completely filled by the "falls" of the roof and "creeps" of the floor; extensive rupture of the stratification occurred, and through this broken ground great leakage must take place. This would seriously affect a long continuous air course, therefore, the way to meet this difficulty was to split, shorten, and enlarge the air channel. The details of two experiments at the Eaglesbush and Ynis David Collieries, where the air was pumped out by Mr. Struvé's Mine Ventilator, showed that a large proportion of the air was drawn from the old workings, and the "goaf," or broken ground surrounding the colliery, and did not come down the intake shaft, and traverse the actual workings, as it ought to have done.

In both these cases, the enlarging and splitting of the air channels, so as to reduce the velocity of the air to about three feet or four feet per second, would have produced most beneficial results.

These principles were shown to have been lost sight of in the majority even of the great collieries, and the power of rarefaction by a furnace was trusted to for dragging the long column of air over and through innumerable impediments. In some cases this was left to be produced by the increased temperature of the mine, from the candles, and the respiration of the men, aided by the cooling effect of water trickling down the intake shaft. These scarcely sufficed to produce an average difference between the two shafts of thirteen degrees in winter, whilst in the summer, and in certain states of the atmosphere there was no difference at all, and, consequently, little or no ventilation. Where rarefaction by heat was used, the temperature in the upcast shaft varied from ninety degrees to one hundred and sixty degrees; this, however advantageous for ventilation, was injurious to the shaft itself, and absolutely dangerous to the men who had to traverse it.

A comparison of the dimensions of the air passages and the velocities of the currents in numerous collieries, led to an estimate of the motive power required to produce the results attained in the best ventilated mines, in case of the employment of a steam-engine and air-pumps. This power would have varied between 23-horse power and 30-horse power.

The efficiency of furnace ventilation was always increased by the depth of the shafts, especially if they were entirely devoted for the purposes of ventilation, irrespective of the working of the pit.

The experiments of Mr. Nicholas Wood, Mr. G. Elliot, Mr. H. Vivian, and other mining engineers, were then quoted, to demonstrate the insufficiency of the "steam-jet," as a means of promoting ventilation, showing that it was a most wasteful application of power, when compared with the steam force employed to work Struvé's Mine Ventilator at the Eaglesbush Colliery. This apparatus consisted of two hollow pistons, resembling large gasometers plunging into cisterns of water, and having inlet and outlet valves. The pistons received alternate motion from a small steam-engine of 5-horse power; and being filled and emptied at each revolution of the crank, produced a regularity of current and a degree of copious ventilation hitherto unknown in the mines to which they had been applied. The small cost of their establishment—only about one hundred pounds for an extensive mine—joined with the little liability to getting out of order, was much in their favour.

The paper terminated with copious extracts from the able mining reports of Mr. John Phillips and Mr. Kenyon Blackwell, confirming all the positions assumed by the author.

Nov. 26.—The discussion upon Mr. Struvé's paper occupied the whole of this evening, and will be resumed on Tuesday, December 3rd.

We understand that a Telford medal in silver has been awarded to G. B. Thorneycroft, Esq., of Wolverhampton, by the council of the Institution of Civil Engineers, for his paper "On the manufacture of malleable iron, and on the strength of railway axles," read during the session of 1849-50. The medal will be presented at the annual meeting on Tuesday evening, the 17th of December next.

ROYAL SCOTTISH SOCIETY OF ARTS.

THIS Society commenced its annual sittings on the 11th ult., in its new and commodious hall, George Street, when Thomas Grainger, Esq., C.E., the President, opened the session by an eloquent address.

The following Paper was read:—

"*An Account of the Chimney of the Edinburgh Gas-Works, with Observations on the Principles of its Strength and Stability.* By GEORGE BUCHANAN, Esq., F.R.S.E., C.E.

In Part I. of this paper Mr. Buchanan gave a very interesting account of this remarkable structure, and the principles of its strength and stability. It was one of the works particularly alluded to by the President in his interesting introductory address last year, and of which he thought it important that the Society should have some account; and Mr. B. having been professionally connected with the work, had much pleasure, at the President's request, in now stating what he knew of it. Having communicated also on the subject with the Gas Company, Mr. Watson, the manager, was most anxious to give information and every facility in his power to forward the great objects of the society; and Mr. Taylor, the engineer of the works, and by whom the chimney itself was designed, has made out a detailed description and drawing, showing minutely the dimensions and structure of every part of the work, and which he now requests Mr. B., along with his paper, to present to the society.

It was about the year 1848, owing to the extension of the works, that it became necessary to obtain increased chimney accommodation, both for increasing the draught of the furnaces and for carrying off the smoke and vapours from the works, and clear away from the neighbourhood by raising the chimney to a greater height. Three chimneys were then on the works, the highest of them rising 148 feet, and not exceeding 2¼ feet square internally at the top. These gave vent to the smoke and vapours of 68 furnaces, heating 178 retorts, but were inadequate to work these effectually, and to give proper ventilation for cooling and purifying the retort houses for the comfort of the workmen, still less to meet the extensions of the works then contemplated and since executed. Instead of continuing, however, the system of small and low chimneys, and adding to their number, the plan came to be considered of raising one single chimney, sufficiently large and lofty to receive the flues from all the furnaces, and by one powerful column of heated air to work these, and any contemplated extensions, in a more effectual manner than hitherto, and so as to supersede the others and render any addition unnecessary for a long period. The idea had been acted on in some works already, and the magnificent chimney of St. Rollox chemical works furnished a favourable example. No way deterred, therefore, by the anticipated difficulties, or the great cost of the undertaking,* seeing especially that it promised beneficial results to the public, the directors determined to proceed with the plans made out at their request by Mr. Taylor. Having previously, however, requested Mr. Buchanan's opinion and advice thereon, he then carefully considered the whole subject, approved of the general design, and suggested only slight modifications in the form of the column and other points; but to Mr. Taylor still belonged the merit of the design, which he thought was great, as well as his talents and skill in superintending the work.

Mr. B. then proceeded to state from his reports some of the facts and principles regarding the work, which apply generally to all similar undertakings. And, first, in regard to the form of the structure, whether round or square; the square had been usually adopted in the works, but in the case of an altitude from 300 to 400 feet the round form was decidedly to be preferred, as presenting a less effective surface to the wind, whose violent action in this quarter it was important to diminish by every means. The effect of the wind on a cylindrical surface as compared with a square had been calculated by theory in the ratio of two to three. This is the Law of Resistance so beautifully demonstrated by the commentators on Newton's Principia. Subsequent experiments had proved the effect on the globe and cylinder to be, if anything, rather less than theory, so that we are quite safe in taking it at ⅔; the result is, that with 300 tons, for example, acting on a square tower, we have only 200 on the cylinder of the same diameter, which is most material. The bricks also, by being moulded to the circle, can be built and bound together with all the strength of the arch. On the lower part of the building, again, which is less exposed, and to be built of stone, the square and pedestal form are preferable.

Secondly. The building being intended to be 300 feet and upwards in height, the question arose how far the ordinary brick could withstand the pressure arising from so lofty a column. This difficulty was provided for by the increasing thickness of the walls of the chimney from the top towards the bottom, whereby the incumbent pressure being distributed over a larger and larger surface in descending, was diminished in proportion. The whole height from the foundation to the top is 341½ feet; of this 77½ feet are occupied by the foundation and square pedestal of stone, and 264 feet by the brick-work, the thickness of which was diminished towards the top by five successive steps. The upper division extended 83 feet down, and was 15 inches thick, and the internal diameter 11 ft. 4 in. at top; the 2nd division 58 feet and 20 inches thick; the 3rd, 48 feet and 25 inches; the 4th, 40 feet and 30 inches; and the 5th, 35 feet and 36 inches thick, and internal diameter 20 feet. On calculating the weight and pressure on each of those divisions, on the first it was found not to exceed 4½ tons on each square foot; in the middle it increased to 7 tons, and at the base it increased to 8 tons on each square foot. The strength of ordinary brick being estimated at from 20 to 30 tons, the work seemed within the limits of safety; but on finding that a composition brick could be obtained in the neighbourhood, from the brick works of Mr. Livingston, of Joppa, of much superior strength, Mr. Buchanan strongly recommended these, and also suggested experiments on their strength, of which he would give further details on another evening, but found the first specimen tried bore at the rate of 440 tons to the square foot, a degree of strength almost incredible in such material. The results of the other experiments were somewhat similar, and all such as to set at rest any fears of the result. In regard to the sufficiency of the foundation itself, although this sustained the whole mass of the building, amounting to 4000 tons, yet the weight being spread over the entire area of the solid base, 40 feet square, it did not exceed 2½ tons to the square foot. And the material consisting of very hard till or blaes, of pretty equal solidity throughout, this appeared to form a good and sufficient foundation; and in order to be perfectly secure, the building at one of the angles was carried deeper than the rest, to obtain the same hard and solid bearing throughout. The result of these precautions, it is now very satisfactory to observe the structure standing perfectly upright and entire, without a crack or flaw of any description to be found in it.

The next object of importance that came to be considered was the effect of high winds on the building. From experiments, it was calculated that the force of a storm or tempest is equal to 12 lb. on the square foot of surface directly exposed; a great storm 18 lb., a hurricane 30 lb., and one capable of tearing up trees and oversetting buildings, 50 lb. There is no instance, however, of such a hurricane occurring in this country, and we are quite safe in assuming 40 lb. per foot, or 90 miles an hour, as the utmost power of the wind in this country. The French engineer, Fresnel, in an interesting memoir on the stability of the lighthouse of Belleisle and various other lighthouse structures compared with it, has assumed the force of the wind at 55 lb., agreeing with the estimate of another engineer, Navier; but this is evidently much beyond the truth, and the effect was to bring the gas-chimney in Paris below the zero of stability, although it stands as yet quite secure. Consider only the human body, which presents a surface from four to six feet square. Such a force of wind would be equal to a pressure of from 200 to 300 lb., and the power to overset at least equal to 500 lb., which no one could sustain for a moment, and even the ordinary inclosure-walls or chimneys would be immediately prostrated by it. Besides, it appears from observations of wind gauges, and particularly of one by Mr. Adie of this city, that the greatest force indicated on it for several years was only 14½ lb.; and another gauge, kept for several years at Granton Pier, and now at the Observatory, never indicated more than 18¾ lb., and this was at Granton on the 9th and 27th of April, 1847. If we allow 40 lb., therefore, we are quite safe, this being nearly double what ever occurs.

Another point must be kept in view, that the tendency to overset the structure is greatly increased by the altitude, and this in fact exactly in proportion as the height exceeds the breadth of the base. It might happen also, if the strength of the different portions of the column were not duly proportioned, that it might be overset, not at the base, but at some intermediate point between it and the top. Applying these views, it was found that in the upper division, 83 feet down from the top, the force of the wind was 14½ tons, and this increased by the height and narrow base to 70 tons,

* The whole cost of the work has been little short of 6000l. One of much less magnitude would have been sufficient for immediate wants—but after due consideration they thought it best to do the plan effectually at once.

while the actual weight was 270, giving a preponderance of stability of $2\frac{3}{4}$ to 1.

Taking the middle division, 160 feet from the top, the force of the wind was 37 tons, and this increased by altitude to 315 tons; but the weight of the structure being 860, there still remains a preponderance of stability of $2\frac{3}{4}$ to 1.

At the base of the column the force was 63 tons, increased by height to no less than 630, while the weight was 1670 tons, giving a preponderance of $2\frac{5}{8}$ to 1, or rather less than the other points, and showing that the column could not overset but at the base.

At the base of the pedestal, again, the stability was fully greater, being $3\frac{1}{2}$ to 1.

These results appeared very satisfactory, and the execution of the work has strikingly confirmed them. The stability and steadiness of the chimney, even in high winds, is remarkable; and while the old chimney, which is not half the altitude, is seen oscillating most sensibly by the naked eye, it is difficult to detect the smallest movement in the other by accurate telescopic observations with the theodolite. It is only in a violent gale, such as occurred on November 7th, that even a slight degree of oscillation could be distinctly observed. And when we consider how very usual it is for structures of this kind to oscillate in high winds (and even some of the lighthouses, which are of a more solid character, are not exempt from it), it is a strong proof of the strength of the work.

Drawings were then exhibited, and the comparative stability calculated of the small gas chimney, and of several other chimneys here and in France, all which were considerably below the present, and the French one pronounced by Fresnel as showing great hardihood—also the relative proportions and heights of some lighthouses; and lastly, a comparison was made, and drawings exhibited and described of the great chimney of St. Rollox, 455 feet in height, and consisting externally of a single cone tapering from the base to the summit, but not quite regularly, 41 feet in diameter at the base, and 13 at the top. The walls are in five divisions, increasing in thickness from top to bottom.

Another source of danger to be guarded against in these chimneys is the intense heat which often arises from the furnaces, and the powerful draught of the chimney. As a protection, an interior tube or chimney is generally built of brick standing clear of the outer chimney, and on which the effects of intense heat may be expended before it reaches the main exterior chimney. This is very effectual, but still the heat is great in issuing from the inner chimney, which should not be carried too high. In the present case, the inner chimney, 13 feet diameter, and lined with fire-brick, rises only 70 feet, and the walls of the chimney being then 36 inches thick, present great resistance; but as an additional precaution, he recommended near this part, hoops of iron, which have been carried at intervals of 35 feet all the way up within, and inclosed by the brick-work, so that they are not visible.

The only point remaining to be considered, and to which Mr. B.'s attention was particularly called, was the expediency of protecting the building by a lightning conductor. He had formerly, when the old chimney was erected, been consulted as to this, and considered it unnecessary, the height being moderate, and doubts being then entertained of the efficacy or expediency of such instruments. Much, however, has since been added to our knowledge and experience on this subject, and on the beneficial operation of conductors; so that he had no hesitation, the altitude also being so much greater, in recommending it. But having requested to be favoured with the views of a friend, and high authority, Professor Faraday, he gave an extract from his letter as follows:—"The conductor should be of $\frac{1}{2}$-inch copper rod, and should rise above the top of the chimney by a quantity equal to the width of the chimney at the top. The lengths of rod should be well joined metallically to each other, and this is perhaps best done by screwing the ends into a copper socket. The connection at the bottom should be good; if there are any pump-pipes at hand going into a well they would be useful in that respect. As respects electrical conduction, no advantage is gained by expanding the rod horizontally into a strap or tube—surface does nothing, the solid section is the essential element.* There is no occasion of insulation (of the conductor) for this reason. A flash of lightning has an intensity that enables it to break through many hundred yards (perhaps miles) of air, and therefore an insulation of 6 inches or 1 foot in length could have no power in preventing its leap to the brickwork, supposing that the conductor were not able to carry it away. Again, six inches or one foot is so little that it is equivalent almost to nothing. A very feeble electricity could break through that barrier, and a flash that could not break through five or ten feet could do no harm to the chimney."

"A very great point is to have no insulated masses of metal. If, therefore, hoops are put round the chimney, each should be connected metallically with the conductor, otherwise a flash might strike a hoop at a corner on the opposite side to the conductor, and then on the other side on passing to the conductor, from the nearest part of the hoop there might be an explosion, and the chimney injured there or even broken through. Again, no rods or ties of metal should be wrought into the chimney parallel to its length, and, therefore, to the conductor, and then to be left unconnected with it."

In answer to some further inquiry, Professor Faraday again writes:—

"The rod may be close along the brick or stone, it makes no difference. There will be no need of rod on each side of the building, but let the cast-iron hoop and the others you speak of be connected with the rod, and it will be in those places at least, as if there were rods on every side of the chimney.

"A three-fourth rod is no doubt better than a half-inch, and, except for expense, I like it better. But a half-inch has never yet failed. A rod at Coutt's brewery has been put up $1\frac{1}{4}$ inch diameter, but they did not mind expense. The Nelson Column in London has a half-inch rod—three-fourths is better.

"I do not know of any case of harm from hoop-iron inclosed in the building, but if not in connection with the conductor I should not like it; even then it might cause harm if the lightning took the end furthest from the conductor."

The rod was constructed nearly according to these directions, of $\frac{3}{4}$-inch copper, and the effect of it was very remarkably exemplified during the progress of the work. It was carried up regularly along with the building, and during storms, or a very electric state of the atmosphere, the electric fluid was distinctly perceived rushing down the rod, by a loud singing noise given out by it, arising from a tremor or vibration into which it was thrown, by a little play in the studs or eyes through which it passed in the building, and during these times the workmen were by no means fond of approaching too near it, but no harm ever occurred to any one from it.

The work of the chimney was commenced by laying the foundation on the 3rd of June, 1845, and during the course of that season the mason-work of the pedestal was completed, and the work allowed to stand til the spring. The brickwork of the shaft was commenced on the 2nd of May, 1846, and proceeded rapidly during the summer. The bricks and all the materials were taken up in the inside by means of a steam-engine working at the bottom, and winding a rope over a barrel, and this passing over a pulley on the top of the building, the materials were raised with the greatest facility; and it was curious to observe from different parts of the tower the work gradually rising, and the workmen steadily going on, at the great elevation to which they at last attained. A model was shown of a very simple apparatus, by which the stage for the materials and timbers was raised by successive lifts, as the building rose in height.

The contractors for the mason-work of the stone pedestal were Messrs. Gowan, and for the brick-work of the stalk Messrs. Bow, of Glasgow, to whom much credit is due for the superior style in which they have finished their work; and it may also be mentioned, that no accident or casualty of any serious nature occurred during the execution of this great work.

Several observations still remained to be made on Part II. as to the draught of the chimney, but were deferred to another day, as well as Mr. Taylor's paper, to give time for the distribution of the prizes for last session.

Thanks voted to Mr. Buchanan.

NOTES OF THE MONTH.

Sir John Rennie and Mr. Brunel, at the request of the parish authorities, have made their report on the failure of Warren's Girder Bridge, over Joiner-street, London-bridge (*ante* p. 390), which contains their joint and decided opinion,—that the bridge, as constructed, was insufficient, and ought not to be replaced by one of similar construction.—Mr. Barlow, the engineer of the railway, has addressed a letter to the *Times*, stating that he entirely disagrees with the above report; and that he does not consider the principle of the bridge either incorrect or objectionable. We advise Mr. Barlow not to kick over the traces; he had better keep quiet and make the best of a bad business. We are very anxious to hear the result of the testing of the bridge; we left our card with Mr. Barlow's assistant at the time the experiment was being made, and begged that he would favour us with the amount of deflection for every 10 tons' dead weight laid over two of the girders, and the final result of the experiment. Although the testing took place three weeks since, we have not been favoured with any particulars. If Mr. Barlow wishes to stand well in his profession, we advise him not to conceal any similar information; he may rely upon it that a fair statement does more good than any concealment.

Portugal boasts of her first steam-engine. A tug, with engines from an English factory at Oporto, has towed a ship over the bar of the Douro. The Portuguese speak of being independent of foreign aid in constructing engines. Save the mark!

The third number of Mr. Tinkler's 'Architectural Sketches in Italy' is partly occupied with villa subjects, which will naturally be of interest to his readers. Some of these villas are suited only to the Roman climate and habits of life; but their picturesque arrangements will afford some ideas for study here, and they will therefore be the more valuable, as they are suggestive without admitting of direct copying. Some of the gateways, sketched under the name of Fragments at Rome, are likewise of considerable interest.

* The very reverse of what was formerly held by high authorities.

The *United Service Gazette* makes the following remarks on the construction of an efficient new dock at Devonport:—"On the 21st the whole Board of Admiralty, with the principal Secretary, assembled at Somerset House, and sat for many hours in deliberation on the subject. The Devonport Master Shipwright was in attendance with *his* plans, and Colonel Green, the C.E. and Architect of the Board, was also present to support the plans which have been condemned by Mr. Edye, and are now being carried out at an enormous expense. The world will laugh at the idea of these men setting up themselves to correct such celebrated civil engineers as Walker, Rendel, and Cubitt—names rendered historical by their great works, and will not fail to remember the Shakesperian adage, 'Fools rush in where angels fear to tread.' The first stone of the new basin dock, according to the Admiralty plan, was laid on the 20th, without form or ceremony of any kind. It was characteristic of the abortive plan; and with so untimely a birth, we cannot help prophecying that this Somerset House infant will never live to be reared."—Our contemporary continues: "We notice with great regret the report that the caissons at the new and spoiled steam basin and dock works at Keyham have failed, although so much was said of their admirable perfection and utility when tried the other day, and of the *inventor*, Mr. Scamp, Assistant Director of Engineering Works at the Admiralty. The whole design looks very much like a gigantic blunder, at the expense of some 20,000*l.*; and now it is said the Admiralty department are endeavouring to make Mr. Fairbairn, the contractor for building the caissons, responsible for the design as well as for the faithful construction of them. Thus, if the caissons had succeeded, the wiseacres of Somerset House would have assumed all the credit; but now that they are likely to fail, or have not succeeded, the contractor is saddled with the onus of the mistake."

LIST OF NEW PATENTS

GRANTED IN ENGLAND FROM NOVEMBER 2, TO NOVEMBER 21, 1850.

Six Months allowed for Enrolment unless otherwise expressed.

Matthew Hodgkinson, of Red-street, near Newcastle-under-Lyne, Stafford, mine agent, for improvements in furnaces or apparatus for smelting ores and minerals, and for the making of pig iron.—November 2.

Victor Emile Wormont, of Neuilly, Seine, France, for improvements in dyeing wool and other fibrous materials and fabrics.—November 2.

Joseph Christian Davidson, of Yalding, Kent, brick maker, for improvements in lime and other kilns and furnaces.—November 2.

John Matthews, of Kidderminster, foreman, for improvements in sizing paper.—November 2.

Jonas Bateman, of Upper-street, Islington, cooper, for improvements in life-boats.—November 2.

Archibald Slate, of Woodside Iron Works, Dudley, for improvements in canal navigation.—November 2.

Pierre Antoine Auguste de la Barre de Nanteuil, of Leicester-street, Middlesex, for improvements in propelling carriages. (A communication.)—November 2.

William and Colin Mather, of Salford, engineers, and Ferdinand Haselowsky, of Berlin, Prussia, engineer, for improvements in machinery, for washing, steaming, drying, and finishing cotton, linen, and woollen fabrics.—November 2.

John Borland, of Norfolk-street, Strand, engineer, for certain improvements in weaving machinery.—November 2.

John Slate, of Wandsworth, Surrey, accountant, for improvements in stoves and furnaces, and in chimney-pots and regulators.—November 2.

John Tatham and David Cheetham, of Rochdale, Lancaster, machine-makers, for certain improvements in the manufacture of cotton and other fibrous materials and fabrics composed of such materials.—November 2.

Richard Clyburn, engineer to the firm of D. Maclean and Son, of St. George-street East, Middlesex, for improvements in wheel carriages. (A communication.)—November 2.

James Black, of Edinburgh, machine-maker, for a machine for folding. (A communication.)—November 7.

Richard Archibald Brooman, of the firm of J. C. Robertson and Co., of Fleet-street, patent agents, for improvements in railways. (A communication.)—November 7.

William Fairbairn, of Manchester, Lancaster, civil engineer, for improvements in cranes and other lifting or hoisting machines.—November 7.

William Crane Wilkins, of Long-acre, Middlesex, engineer, for an invention for lighting, and in apparatus for lighthouses, signal, floating, and harbour lights.—November 7.

Samuel Edwards, James Ansell, and Patrick Heyns, of Shadwell, Middlesex, engineers, for certain improvements in obtaining and applying motive power, and in pumps.—November 7.

George Frederick Morrell, of Fleet-street, London, gentleman, for improvements in obtaining and applying motive power, and also in pumps.—November 7.

John Alexander Lerow, of Boston, America, gentleman, for certain improvements in sewing machines.—November 7.

Benjamin Guy Babington, of George-street, Hanover-square, Middlesex, Doctor of Medicine, for improvements in preventing incrustation of steam and other boilers.—November 7.

Robert Clare, jun., of Exchange-buildings, Liverpool, gentleman, for improvements in the manufacture of metallic casks.—November 7.

John Robinson, of Stepney, Middlesex, engineer, for improvements in lifting and moving fluids and other bodies, and in apparatus for steering ships and other vessels.—November 7.

David Christie, of St. John's-place, Broughton, Salford, Lancaster, merchant, for improvements in machinery or apparatus for preparing, carding, spinning, doubling, twisting, weaving, and knitting cotton, wool, and other fibrous substances, also for sewing and packing. (A communication.)—November 7.

Robert Lucas, of Furnival's-inn, London, mechanical draughtsman, for improvements in telegraphic and printing apparatus. (A communication.)—November 7.

Thomas Main, of the Strand, printer, for improvements in printing machinery.—November 8.

James Rock, jun., of Hastings, Sussex, coach-builder, for certain improvements in carriages, which are also applicable, in whole or in part, to other machinery.—November 11.

William Palmer, of Sutton-street, Clerkenwell, manufacturer, for improvements in the manufacture of candles and night lights.—November 9.

James Scott, of Falkirk, N.B., shipwright, for certain improvements in docks, slips, and apparatus connected therewith.—November 9.

Sir Francis Charles Knowles, of Lovell, Bucks, Bart., for improvements in the manufacture of charcoal.—November 9.

Lucien Vidie, of 14, Rue du Grand Chantier, Paris, France, French advocate, for improvements in measuring the pressure of air, steam, gas, and liquids.—November 9.

Joseph Nye, of Mill Pond Wharf, Old Kent-road, engineer, for improvements in hydraulic machinery, parts of which improvements are applicable to steam-engines and machinery for driving piles.—November 12.

George Robins Booth, of London, engineer, for improvements in the manufacture of gas.—November 12.

Peter Spence, of Pendleton, Manchester, manufacturing chemist, for improvements in the manufacture of alum and certain alkaline salts, and in the manufacture of cement, part of which improvements are applicable in obtaining volatile liquids.—November 12.

Edwin Clark, of Palace New-road, Middlesex, civil engineer, and Henry Mapple, of Child's Hill, Hampstead, for improvements in electric telegraphs, and in apparatus connected therewith.—November 12.

Henry Medhurst, engineer, in the employ of Messrs. Shears and Sons, of Bankside, Southwark, for improvements in gas meters.—November 12.

Etienne Masson, of Place St. Michael, Paris, gardener, for improvements in the preparation of certain vegetable alimentary substances for the provisioning of ships and armies, and other purposes where the said substances are required to be preserved.—November 12.

John Bull, of Ashford, Kent, engineer, for improvements in applying heat to bakers' ovens and their appendages.—November 12.

Henry Wimshurst, of Limehouse, Middlesex, shipbuilder, for improvements in steam-engines, in propelling, and in the construction of ships and vessels.—November 12.

Charles Marsden, of Kingsland-road, Middlesex, engineer, for improvements in scissors and thimbles.—November 12.

William Duckworth, of Liverpool, coffee merchant, for certain improvements in the manufacture of chicory, with certain improvements in the machinery or apparatus for the manufacture thereof.—November 14.

Thomas Shore, of Exwich, Devon, miller, for an improved method of dressing flour.—November 14.

Robert Howarth, of 61, Chapman-street, Oldham-road, Manchester, for improvements in machinery for raising a nap on cotton, woollen, silk, and other fabrics.—November 14.

Abraham Haley, of Frome, Somerset, machinist, for certain improvements in looms for weaving.—November 14.

Edward David Ashe, of Brompton, Middlesex, Lieutenant in her Majesty's navy, for a new or improved nautical instrument or instruments applicable especially amongst other purposes to those of great circle sailing.—November 14.

John Swindells, of the firm of Swindells and Williams, of Manchester, and Ince, near Wigan, manufacturing chemist, for certain improvements in obtaining products from ores and other matters containing metals, and in the preparation and application of several such products, for the purpose of bleaching, printing, dyeing, and colour making.—November 14.

Joseph Conrad Baron Liebhaber, of Paris, France, for improvements in blasting rocks; also in working marble and stone, and in preparing products therefrom.—November 14.

Charles Allemand, of Paris, France, gentleman, for an improved apparatus for producing light.—November 14.

Thomas Coats, of Ferguslie, Paisley, Renfrew, Scotland, thread manufacturer, for certain improvements in turning, cutting, and shaping wood and other materials.—November 16.

Joseph Martin, of Liverpool, Lancaster, rice miller, for improvements in machinery and apparatus for cleansing and otherwise treating rice and other grains, seeds, and farinaceous substances.—November 16.

Thomas Allan, of St. Andrew's-square, Edinburgh, printer and publisher of the *Caledonian Mercury*, for certain improvements in electric telegraphs, and in the application of electric currents for deflecting magnets and producing electro-magnets.—November 16.

William Laird, of Liverpool, Lancaster, merchant, and Edward Alfred Cowper, of Handsworth, Warwick, engineer, for improvements in machinery for loading and discharging certain descriptions of cargo in ships and other vessels, and in the construction of such vessels.—November 16.

John Hosking, of Islington, Middlesex, engineer, for certain improvements in valves applicable to pumps, and also in apparatus to regulate the pressure and flow of water and air through pipes.—November 19.

Thomas Dunn, of Windsor Bridge Iron Works, Pendleton, near Manchester, Lancaster, engineer, for improvements in machinery and apparatus for moving engines from one line of rails to another, and for turning them; also for compressing certain substances, and for raising and lowering heavy bodies.—November 19.

Paul de Tolstoy, of Paris, France, General in the service of his Majesty the Emperor of Russia, for improvements in dredging machines. (A communication.)—November 19.

Clement Augustus Kurtz, of Manchester, Lancaster, practical chemist, for improvements in dyeing. (A communication.)—November 19.

Alfred Vincent Newton, of Chancery-lane, Middlesex, mechanical draughtsman, for an improved composition applicable to the coating of wood, metals, plaster, and other substances which are required to be preserved from decay, which composition may be also employed as a pigment or paint. (A communication.)—November 19.

Robert Brown, of Liverpool, Lancaster, plumber and brass-founder, for improvements in the application of pumps for raising and forcing water.—November 19.

Henry William Ripley, of Bradford, York, dyer, for improvements in dressing and finishing piece goods.—November 19.

John James Greenough, of the Strand, Middlesex, gentleman, for improvements in the construction of chairs, couches, and seats, parts of which improvements are also applicable to various purposes where springs for supporting heavy bodies and resisting sudden and continuous pressure are required. (A communication.)—November 21.

ERRATA.—In the article on "Motion of Water in Pipes," p. 374, col. 2, line 54, *for* "E and I," *read* "A and I;" line 67, *for* "of," *read* "at," line 68, *for* "increasing," *read* "indicating."

Page 375, and throughout the paper, *for* "x," *read* "a;" col. 2, line 36, and 42, *for* "formulæ," *read* "formula."

Page 376, col. 1, line 19, *for* "Changes," *read* "Change;" line 38, *for* "Yénieys," *read* "Génieys;" line 64, *for* "bend," *read* "head.—Col. 2, line 12, *for* "bend," *read* "head;" line 24, *for* "aperture at the end," *read* "aperture of discharge;" line 30 and 50, *for* "S^2_n," *read* "s^2_n."

END OF VOLUME XIII.

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